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Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The Niagara Falls tunnel will probably be finished Oct. 1, and the wheel pit excavation shortly after. Power will begin to be furnished toward the end of March, at latest, possibly in January, and at two points: 1. The central station where about 10,000 HP. will be turned out from three 5,000-HP. wheels, which will probably be converted into electricity and distributed. By enlarging the wheel pit ten 5,000-HP. wheels can be put at this point. 2. About 3,000 HP. for the Niagara Falls Paper Co., which is furnished at the extremely low price of $8 per year per 24-hour HP., we understand. The company's public announcements of rates for power are $10 per HP. for 5,000 HP. or over; $10.50 for 4,500 HP.; $11 for 4,000 HP., and so on down to $21 for 300 HP., all for 24-hour power if wanted, the cost of ordinary steam power for a 10-hour day ranging from $25 to $40. There will be seen to be a large margin, therefore, even from the higher rates for the water power. The ultimate capacity of the tunnel is some 100,000 HP. of 24-hour power.

The tunnel on the Canadian side will also be pushed soon by the same company, stimulated by the fact that it has to pay a royalty of $25,000 per year to the Canadian Government for their franchise. A tunnel only one-tenth as long is needed to develop 100,000 HP. on the Canadian side, however. The power from the Canadian side is likely to be transmitted to Buffalo. While details are very naturally withheld, it is credibly asserted that several large consumers of power are only awaiting the completion of these tunnels to remove their works to various points on the 18-mile strip of territory between Buffalo and the Falls, the value of all of which has risen enormously.

The new eight-hour law is upsetting the work of the government engineers very extensively. All contracts on which bids had been called for, but which were not closed on Aug. 1, are being readvertised; and sections 1 and 2 of the law, as printed last week, are made a part of all proposals issued and all contracts hereafter closed. Engineers estimate that the cost of all work done under the new law will be increased from 20 to 40%.

Operations of the U. S. geological survey will be considerably curtailed by the reduced appropriation made in the Sundry Civil Bill. Nearly 40 members of the present force will be asked for their resignations. Most of those dispensed with will be scientists employed on special work. About 26 other members of the staff will have their salaries reduced.

The Missouri Geological Survey reports on the iron ores, and one on the mineral waters of the state, are now being revised and prepared for the printer. The survey is actively progressing in every department, under charge of Prof. Arthur Winslow, State Geologist.

The gross earnings of 146 railways for the month of July show a small increase, 2.34%, over those for the corresponding month of 1891, according to the "Financial Chronicle." This showing is quite favorable considering the adverse conditions with which the railways, especially in certain sections, have had to contend. Of the 146 roads reporting earnings 74 show decreases from last year's figures. These decreases come chiefly from two sections of the country, viz., the South where a state of great depression prevails, and the Middle and Middle Western states, where the iron troubles and smaller grain movements have exerted the most influence. Outside of these sections the exhibits are on the whole quite good, and especially favorable returns are shown by the Northwestern railways. As during previous months of this years returns of the Southern roads are very poor. Only seven of the 35 roads reporting exhibit improvements over last year's earnings.

The most serious railway accident of the week was a sidetrack collision Aug. 15 near Coshocton, O., on the Toledo, Walhonding Valley & Ohio Ry., a new road under construction. A ballasting gang had been ballasting the roadway three miles north of the gravel pit, and after the last train had been unloaded, the men boarded the cars that were being pushed ahead of the engine to go to their boarding camp. The train was running at a high speed, and when it arrived at the gravel pit, which was to be passed without stopping, the switch was open and the train entered the siding and collided with some empty cars. The greater number of the workmen were seated on the first and second cars, and when the long train turned in upon the spur they had no opportunity to jump. Ten of the cars were wrecked. Six men were killed and 15 injured. The accident was due to the carelessness with which switches are generally attended to and trains operated on construction tracks.

Two other serious railway accidents occurred. One was a derailment Aug. 13 on the Chicago & Northwestern Ry., at Mill Creek, Ia. One truck of a sleeping car of a special passenger train left the rails, and the car rolled down the bank, landing bottom up. Of 25 persons, 14 were more or less injured, but only one seriously injured. Two other cars were derailed and the passengers shaken up and bruised.—A similar accident occurred Aug. 9 at Petersburg, Colo., to an Atchison, Topeka & Santa Fe R. R. passenger train. All the cars were derailed, except the dining car at the rear. Nine persons were injured.

A highway bridge over the canal at Buffalo, N. Y., gave way under a team Aug. 7. According to press dispatches, Mr. McDonough, Canal Superintendent, is of the opinion that the hub of the wagon caught in a part of the truss, and the driver, instead of backing, thrashed the horses and distorted the truss so as to cause the collapse. The dispatches also say that the wooden beams were rotten. Mr. E. B. Guthrie, engineer in the Department of Public Works, Buffalo, writes us as follows:

> The bridge that fell in this city belonged to the state, being over a slip under its control. It was about 85 ft. long, with two Whipple cast iron trussed arches, 20 ft. centers, with two 8-ft. walks outside. The floor beams were of cast iron; joists were wood. I do not know when it was erected, nor exact cause of accident. A team was passing at the time, and I have been unable to learn more than that the north arch first fell, giving way at westerly end. A visit to the site as the wreck was being cleared away, with parts of the arch removed to a scow, disclosed no fractures but such as were evidently caused at time of fall. The ends of lower chord were still in the water, except parts hanging from abutments, which were without fracture. I send you clipping giving Supt. McDonough's theory of the cause of the accident.

The 100-lb. rail section of the Pennsylvania R. R., illustrated in our issue of July 21, has been revised by Mr. Brown, Chief Engineer. He has made the width of base equal to the height, or 5½ ins. instead of 5 ins., as shown on the published section.

Steel rails 60 ft. long are now being laid on 50 miles of the Norfolk & Western R. R. A form of bridge joint, invented by Mr. Churchill, Engineer of Maintenance of Way, is being used, and we shall give particulars later.

A water power dam is being built across the Merrimack River at Sewall's Falls, about four miles above Concord, N. H., by the Concord Land & Water Co. The company expects to develop 4,000 HP. and has a ten-year contract for lighting the city by electricity. The dam will be a crib structure 500 ft. long. It will contain 1,250,000 ft. B. M. of hemlock and Georgia pine, 20,000 cu. yds. stone filling and 5,000 cu. yds. of masonry in the abutments. There will be a canal 1,300 ft. long, 12 ft. wide at the top and 38 at the bottom. Mr. E. F. Smith, C. E., Reading, Pa., designed the dam. Mr. W. H. Ward, Lowell, Mass., is the contractor. We are indebted to Mr. Daniel Ulrich, Constructing Engineer, of Buffalo, N. Y., for the information given.

The contract for block signal equipment on the New London Division of the New York, New Haven & Hartford R. R. has been awarded to the Johnson Railroad Signal Co., of Rahway, N. J. The line is mainly double track, and will be divided into block sections about 3½ miles long. The Sykes electric lock will be used, and switches and signals so interlocked that a track clear signal cannot be given unless the switches are set and properly locked.

The report of the Board of Trade, England, on the interlocking plant of railways in Great Britain in 1891, shows that on Dec. 31, 1891, there was 94% of the switch and signal plant interlocked. The increase since 1890 was 1.5%, as follows:

		No. of levers.		Percentage.	
		Interlocked.	Not interl.	Interlocked.	Increase.
England and Wales,	1890	30,854	1,543	95	...
" " "	1891	31,781	1,139	97	2
Scotland,	1890	4,804	742	87	...
"	1891	5,007	667	88	1
Ireland,	1890	1,428	762	65	...
"	1891	1,535	728	68	3
Total Unit'd Kingd'm,	1890	37,086	3,047	92½	...
" " "	1891	38,323	2,534	94	1½

A four-cylinder compound engine, on the Vauclain system, has been built for the Pike's Peak railway by the Baldwin Locomotive Works. The railway is on the Abt rack rail system, 4 ft. 8½ ins. gage, and has been fully described in our columns. The engine has four carrying wheels revolving on the two axles which carry the pinions, and a two-wheel truck under the cab. The coal bunker is behind the cab, and water is carried in two side tanks with an aggregate capacity of 400 gallons. One of the engines on the road is burning oil fuel. The principal dimensions of the new compound engine are as follows:

Cylinders, h.p.	9 × 22 ins.
Cylinders, l.p.	15 × 22 ins.
Diameter of driving pinions (2) (on pitch line)	1 ft. 10½ ins.
Diameter carrying wheels (4)	2 ft. 1¾ ins.
Diameter truck wheels (2)	1 ft. 10 ins.
Wheel base, driving	4 ft. 9¾ ins.
Wheel base, total	11 ft. 9¾ ins.
Weight on drivers	33,200 lbs.
Weight, total	45,850 lbs.
Boiler, diameter	3 ft. 6 ins.
Tubes, 158; diameter, 1¼ ins.; length	7 ft. 6 ins.

The sewage pumping station at Orange, N. J., will soon be ready for contractors' bids. Plans and specifications for it were prepared by the Chief Engineer, Mr. C. Ph. Bassett. The pumping plant will consist of two compound duplex condensing steam pumping engines, each of 1,000,000 gallons daily capacity, furnished with steam by two 50-HP. tubular boilers. The force main will be of cast iron, 10 ins. in diameter. A flue from the top of the sewage tank opens into the chimney, insuring perfect and odorless ventilation.

The marine department of the Maryland Steel Co., at Sparrow's Point, has just completed a side-wheel steamer, to ply on the Rappahanock River, which is the largest vessel thus far turned out at the yard. Her hull measures 205 ft. length and 32 ft. beam, and she is 52 ft. over the guards. Her hull is built of mild steel.

The last of the three 2,000-ton cruisers for the U. S. Navy, for which contracts were let in October, 1889, was launched on Aug. 11 from the yards of Harrison, Loring & Co., of Boston, and christened the "Marblehead." The vessel has no armor protection to speak of; but the coal bunkers are so arranged as to protect the machinery, and coffer-dams of cellulose are carried nearly her whole length.

Dry docks are to be built at Cadiz and Carthagena in Spain, and proposals for their construction will be received until Jan. 24, 1893. Particulars may be obtained from the Minister of Marine, at Madrid. Each dock is to be provided with a lock and floating gate or caisson. They are to be large enough to accommodate vessels of 12,000 tons, and to have the following minimum dimensions: Length, 492 ft.; breadth, 98 ft. 3 ins. at coping and 69 ft. at bottom; draft at maximum high water 36 ft.

The multiple speed railway, or traveling platform, illustrated in our issue of Feb. 27, 1892, has been taken up by an English syndicate, which expects to construct a line near London within the next 12 months. It is likely that a similar line will be constructed in Paris. As heretofore announced the company has secured a concession for a loop within the Columbian Exposition grounds, in which to run its system independently of the intramural railway, and it has also a concession to build a tower 400 ft. high with a spiral railway on the multiple speed system, running to and from the top.

The Transandine Railway, to connect the railways of Chile and the Argentine Republic, is progressing slowly in the Argentine, in consequence of the difficulty in regard to money, and a recent heavy fall of snow in the Andes. It is possible the rails may reach Punta de las Vacas, 88 miles from Mendoza, by October, and there will then remain to be constructed in Argentine territory 20 miles, including some long tunnels. About 200 men are employed. The railway was described and illustrated in our issue of Feb. 13.

THE VYRNWY WATER SUPPLY FOR LIVERPOOL, ENGLAND.

On July 14 the new works for furnishing the city of Liverpool with a water supply from Lake Vyrnwy, 45 miles distant, in the mountains of Wales, by an aqueduct 77 miles long, were formally placed in operation by the Duke of Connaught. Actual work on the Vyrnwy supply has been in progress for just 11 years, the first stone of the great dam having been laid by Earl Powis, on July 14, 1881. At frequent intervals during this period we have reported the progress of the work and illustrated and described its important features, and now that the task is done, we take occasion to describe, as fully as our space permits, the whole enterprise from its inception.

History of the Work.—The demand for a more abundant water supply for Liverpool dates back to the drouths of 1864-'65 and '66, when the supply of water was so inadequate as to make necessary its cutting off during certain hours of the day, a system of operation which has become so common in England that users of water submit to it without grumbling. One can imagine what a howl of indignation would go up were it attempted to supply an American city on the "intermittent" plan. The Chief Engineer of the Liverpool Water Department, Mr. Thos. Duncan, recommended in 1867 the securing of a supply from a lake nearly as far away as Vyrnwy, but the City Council stood aghast at the expenditure involved. By driving some additional wells, purchasing some of the "compensation water" (the portion of the flow on one of the streams supplying the city, which they could not lawfully take), and keeping the water users on short rations, the council managed to get along for seven or eight years. In 1871, Mr. Duncan having died, Mr. Geo. F. Deacon was appointed Chief Engineer of the Liverpool Water Works, and three years later his anxiety to solve the difficulties under which the city labored, led to his invention of the Deacon waste-waste detector, which has since become well known in this country as well as abroad. To such good purpose was this little instrument used in Liverpool, that before the close of 1875 a constant supply was again furnished to the city; and it is stated that the value of the waste water saved by the use of this instrument, reckoned at the rates charged water users, was about $250,000 per annum.

It was manifest, however, that the relief was but temporary. The population within the limits supplied with water by the city of Liverpool is now 800,000. In 1874 it was 625,000, and that population was getting along on a water supply of only 23.8 gallons per head per day, or about 15,000,000 gallons daily. (Chicago in 1890 used on the average about ten times this amount, or about 126.8 gallons daily per capita.)

In 1873 the City Council took up with renewed zeal the question of additional supply. As usual in such cases, a half dozen different sources were proposed, and each had its earnest advocates. In 1876 Mr. Deacon made his first recommendation of the Vyrnwy supply in a postscript to a report on the Haweswater supply, a more distant source. In 1877 and '78 he submitted full reports on the Vyrnwy supply, with maps and plans. These reports the Council submitted in 1879 to Messrs. Thos. Hawksley and J. F. Bateman, both Past-Presidents of the Institution of Civil Engineers, with questions as to the relative merits of the Haweswater and the Vyrnwy supplies. Both reported in favor of the latter supply. Reports on the quality of the water, and on the effect of the peat in the valley on its quality, were obtained from Dr. Frankland, and other sanitary authorities, and in November, 1879, having secured the approval of the best experts on its great enterprise, the Council instructed Mr. Deacon to prepare the detailed plans for the Vyrnwy supply, and appointed Messrs. Hawksley and Deacon joint engineers of the work.

The Source of Supply.—The Vyrnwy River drains a sparsely inhabited, mountainous region in North Wales. The rainfall is very large. Twenty rain gages have been maintained on the watershed for many years, and the highest record is 118.51 ins. per annum. The minimum record is 49.63 ins. The average annual rainfall in Liverpool is about 30 ins. The total area of the watershed above the dam is about 18,000 acres (29 sq. miles), of which some 14,000 acres has been purchased outright by Liverpool. Besides this the flow from two smaller watersheds, respectively 3,000 and 2,200 acres in extent, will eventually be led into the Vyrnwy reservoir by short tunnels, making the total area on which water will be collected about 23,200 acres. The surface of the water in the lake formed by the dam is 825 ft. above sea level. The lake is 4¾ miles in length, and ¼ to ⅝ of a mile in width. It covers an area of 1,121 acres, and its greatest depth is 84 ft. The total quantity of water impounded above the level of the intake is 12,131,000,000 gallons, enough to furnish the contemplated supply of 40,000,000 gallons daily to the city of Liverpool for 300 days without contributions from the watershed.

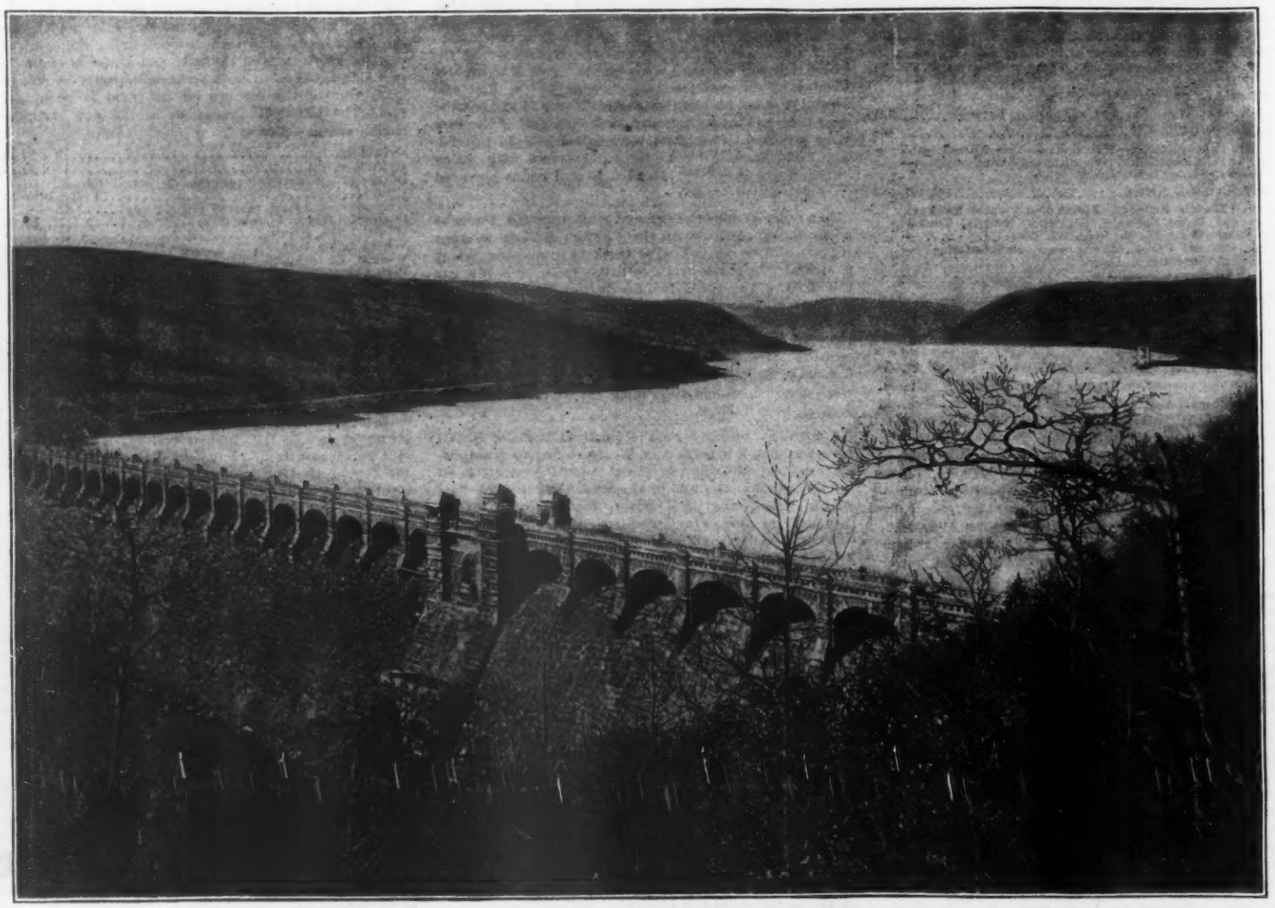


FIG. 1. LAKE VYRNWY, THE NEW SOURCE OF WATER SUPPLY FOR LIVERPOOL.

But in the legislation necessary for carrying out the enterprise, the Commissioners in charge of the river Severn succeeded in introducing a clause requiring 10,000,000 gallons daily of the impounded water, to be discharged down its natural channel, and in addition 50,000,000 gallons on 32 days between March and October. It was the unexpected introduction of this last clause that decided the engineers to raise the dam some 10 ft., increasing the capacity of the reservoir by over one-third.

The territory overflowed by the new lake contained one village of about forty dwellings, called by the picturesque, but unpronounceable name of Llanwddyn. The cottages were torn down, the church was rebuilt on a new site above the lake level, and the dead in the parish churchyard were removed to a place beside it. The valley in which

the lake was formed was quite level, with the hills rising steeply from its borders. It was in fact the bed of an ancient lake, which in time became filled with alluvial deposit. It is thus seen that over a great part of its surface the new reservoir is of uniform and considerable depth, while the banks all around are steep, and slope rapidly off to deep water thus leaving very little shallow water areas to form favorable places for the growth of algae.

A large part of the watershed was covered with forest at the time it was purchased by Liverpool, and since that time other areas have been planted to trees. A carriage road about 12 miles in length has been built around the lake, and a hotel has been erected near the dam. It is expected that the picturesque scenery, with the interest attaching to the great dam as an engineering work will attract many visitors to the valley.

The Great Dam.—In our issue of Dec. 29, 1888, we published a perspective view and cross-section of the dam, which ranks seventh in height among the great masonry dams of the world (see inset in Eng.

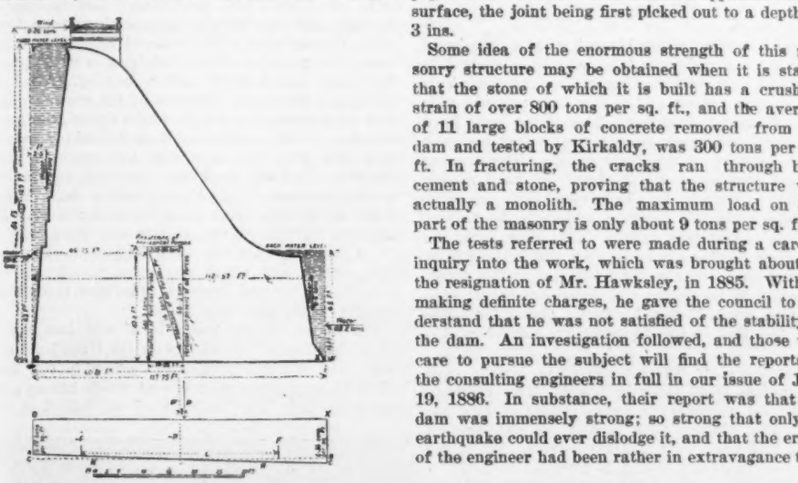


FIG. 2. LONGITUDINAL AND CROSS SECTIONS OF VYRNWY DAM.

News, Jan. 7, 1888), being exceeded only by the Furens and Ban dams in France, the San Mateo dam of the San Francisco water-works, the Gileppe dam in Belgium, and the Villar and Puentes dams in Spain. In designing the works the relative merits of a solid masonry dam and a dam of earth, with a masonry heart, were considered. The former was estimated to cost $3,155,000, and the latter $1,510,000, the estimate for the earth dam, however, contemplated a structure of considerably less height.

We show herewith a section of the dam at the deepest point of the valley, with a diagram of the strains. To found the dam on solid rock it was necessary to excavate a trench 1,100 ft. long, 120 ft. wide and 60 ft. deep at the lowest point. The Vyrnwy River was carried across the trench by a temporary conduit while the dam was being built up to the ground level, and later two temporary culverts were left as the dam was built up, through which the river flowed. The rock foundation when laid bare was cut in steps, and upon this ideally-solid base the masonry was started.

The "cyclopean rubble" masonry of which the dam was built consists of large masses of a very dense and tough slate of irregular cleavages, quarried about a mile from the site of the dam. About 2 oz. of powder per ton of rock detached was used in quarrying; the largest weight of stone permissible was 10 tons. The proportions of stones of different sizes were: Stones under 2 tons 46%; 2 to 4 tons, 26%; above 4 tons, 33%. The lower beds of all stones were roughly dressed to an approximately flat surface and any thin projecting points were knocked off. Each stone was then washed with a powerful water jet. Portland cement, which showed an average strength of 633 lbs. per sq. in. when 8 days old, was used in the mortar, the proportions being 1 part finely broken quarry chips, 2 parts river sand, and 1½ parts cement. The proportion of cement was diminished somewhat in the upper part of the dam. In building up the dam it was the intention to have all stones bedded in this mortar. Cavities between the larger stones were built up with smaller ones until an approximately level surface was obtained. All stones whose weight was not sufficient to thoroughly imbed them in the mortar were pounded with mauls, and the concrete was packed in the small interstices with rammers. Stones cut and drafted were used for the face of the dam on both sides. Below the bed of the lake the trench on the inner face of the dam was filled with clay puddle thoroughly rammed, and from base to top every joint is pointed with rich cement mortar rammed in with peg and flat rammers until moisture appeared on the surface, the joint being first picked out to a depth of 3 ins.

Some idea of the enormous strength of this masonry structure may be obtained when it is stated that the stone of which it is built has a crushing strain of over 800 tons per sq. ft., and the average of 11 large blocks of concrete removed from the dam and tested by Kirkaldy, was 300 tons per sq. ft. In fracturing, the cracks ran through both cement and stone, proving that the structure was actually a monolith. The maximum load on any part of the masonry is only about 9 tons per sq. ft.

The tests referred to were made during a careful inquiry into the work, which was brought about by the resignation of Mr. Hawksley, in 1885. Without making definite charges, he gave the council to understand that he was not satisfied of the stability of the dam. An investigation followed, and those who care to pursue the subject will find the reports of the consulting engineers in full in our issue of June 19, 1886. In substance, their report was that the dam was immensely strong; so strong that only an earthquake could ever dislodge it, and that the errors of the engineer had been rather in extravagance than in any other direction. The report of Mr. A. H. Holmes, a member of the Liverpool City Council, was presented at the same time, and assured the people of Liverpool that though they had paid a high price for their great dam, it was a work which was good and solid all the way through. To show the thoroughness with which the inquiry was pursued, a vertical shaft was sunk and a heading driven into the heart of the dam, which was then about two-thirds completed. From this time onward the work was in sole charge of Mr. Deacon.

The details of the design of the dam are of considerable interest. Along its crest extends the viaduct which carries the roadway around the lake. The overflow from the lake is over the face of the dam; the length of the overfall being 593 ft.; the water flows between the arches of the viaduct. The two 15-ft. culverts which carried the flow of the river while the dam was building were filled up with masonry afterward. In one of them a 39-in. pipe was built in with two valves, and this will be opened if it is desired to draw the water off from the lake. In the other, an 18-in. and a 30-in. pipe were laid for supplying the compensation water to the river.

Drains were built into the masonry in the back part of the dam, and this was one of the points criticised by Mr. Russell Aitkin, one of the consulting engineers, in his report above referred to. He also commented unfavorably on the plan of imbedding the discharge pipes in the masonry, although he did not consider it as endangering the stability of the dam. One end of the dam is built into the rock at the side of the valley. At the other end a boulder clay deposit overlaid the rocks, and the dam is tied into this with clay puddle. A trench was cut down to the rock and filled with puddle, and against the water face of the dam, from the foundation upward, a puddle wall was formed, the top of which is 58 ft. below the overflow. At the ends of the dam this puddle wall is carried up to the ground level, and at the southwest end it passes round the extremity of the masonry and joins the puddle wall made in the boulder clay. This, in turn, is tied into a recess in the sloping end of the masonry.

The dimensions of the completed dam are as follows:

Total length across valley	1,172 ft.
Height, foundation at lowest point to parapet of viaduct	161 ft.
River bed to parapet	101 ft.
River bed to overflow level	84 ft.
Greatest width of base	120 ft.
Batter of outer face	1 horizontal to 1½ vertical.
Batter of water face	1 horizontal to 7.27 vertical.
Total volume of masonry	200,000 cu. yds.

The following statement of the cost of the Vyrnwy reservoir was published in "Engineering," Feb. 15, 1889:

Borings, trial shaft, river diversions and other preliminary work	$34,000
Excavating 220,820 cu. yds. and back filling 79,501 cu. yds.	287,000
Puddle wall, including excavation	16,800
Masonry and brickwork, including all materials and labor	2,532,000
Regulating and gaging plant	46,000
Basin and other works below dam	40,000
Roads around lake, culverts, fencing, planting, pitching slopes	312,000
Removal of village	54,000
Superintendents' houses	12,000
Total cost	$3,334,000

It will be noted from the above that the masonry cost nearly $10 per cu. yd. The work was all done under the direction of the city officials, no contracts being let.

On Nov. 28, 1888, the valves in the outlet pipes were closed, and within 10 days the lake had attained a length of over four miles.

The Straining Tower.—The inlet tower is located three-fourths of a mile from the dam, and about 140 ft. from the shore in some 50 ft. of water. The location is so chosen as to be remote from the current of any of the lake's tributaries. A stone viaduct of four arches extends to the tower from the shore. The tower is built of masonry similar to that of the dam, has a total height of 160 ft., and is 47 ft. in diameter at the base. The purpose of this structure with its appliances is to draw the water from about 10 ft. below the surface, whatever the level of the lake, also to strain it of all impurities. To effect the first end, two 44-in. cast-iron pipes, made in short lengths, are set vertically in a recess of the tower on the outside, and connect with two similar lines running up on the inside. The ends of each length are turned and faced with gun metal, and the joint between the lengths is made only by the weight of the pipes above resting on those below. The upper end of the outlet pipe column extends above high water mark. To draw water from any desired level, the attendant, aided by a hydraulic elevator, grapples the four pipes just above the joint at that level and raises them bodily several inches; the water enters the tower through the opening thus formed.

Notwithstanding the excellent character of the water, it is considered advisable to strain it, and not merely through a screen, as practised in most American works, but through wire cloth, with 14,000 meshes to the sq. in. (120 wires per in.). Three vertical pipes rise from the base of the tower. Each communicates with the main culvert, and is controlled by a gate worked from above. Upon the mouth of each of these outlet pipes stands a vertical frame of wrought iron, 9 ft. in diameter and 25 ft. high, covered with copper wire gauze of the fineness above stated. Naturally, such a very fine strainer will soon get clogged; this causes a resistance to the flow, and when this resistance reaches a certain amount an automatic alarm sounds, notifying the attendant that the screen must be cleaned. This is done by raising the screen out of the water to the operating platform, by a hydraulic elevator, and washing it with a water jet playing on the inside of the screen.

The hydraulic power required for raising the inlet pipes and the strainers is derived from a tank located on the hillside, about 100 ft. above the strain-

ing tower. The water from this tank operates a water-pressure engine, driving force pumps, which deliver the water under a pressure of about 700 lbs. per sq. in. The inside of the tower may be emptied at any time by closing the inlet and drawing off the water through the main culvert.

The Aqueduct.—From the inlet tower the water is carried through pipes and tunnels about 68 miles, to the distributing reservoir at Prescot. The total distance to the Liverpool Town Hall is 77 miles. The ultimate flow contemplated is 40,000,000 gallons daily; but at present only one of the three lines of pipes which are to carry the flow over most of the

Fig 3. Inlet Tower at Head of Aqueduct.

distance has been laid, so the available supply is at present about 13,000,000 gallons per day. (The daily capacity of the upper portion of the new Croton aqueduct is 318,000,000 gallons.) The total fall from the lowest point of Lake Vyrnwy to Prescot is 496 ft., or about 7½ ft. per mile. In order that this enormous head should not be brought by any possibility on the lower portion of the pipe line, reservoirs were built at five points on the line, dividing the aqueduct into six sections.

The material of the pipe is principally cast-iron, except at some river crossings and tunnels, where steel has been used. The diameter of the pipe varies from 39 ins. to 42 ins., according to the grade, and its thickness is 1 to 2 ins. The greatest static head on any section of the pipe is about 500 ft. With the exception of a few overhead crossings of rivers and railways, the aqueduct is wholly underground, and a considerable portion of it is in tunnel. Where the tunnels are driven through hard rock, the pipe line ends at the tunnel portal, but in porous rock tunnels, and at the Mersey River tunnel, the pipes are carried through.

The various works along the line of the aqueduct are as follows: Starting from the inlet tower the supply pipes very soon terminate at the portal of the Hirnant tunnel, 2⅝ miles in length. The water flows through the tunnel and then enters the pipe line, which continues for seven miles, passing streams and rivers by inverted siphons, except in one case, where a viaduct has been built. It then discharges into the Pare Uchaf reservoir, of 2,000,000 gallons capacity. This is situated on a hilltop, and its walls are built of concrete, faced with blue brick. From this reservoir the pipe line continues for a distance of about seven miles farther, where it enters the Cynynion tunnel, three-quarters of a mile long. Emerging from this, it crosses a narrow gorge, 90 ft., deep by an inverted siphon, and enters the Llanforda tunnel, about a mile in length. These two tunnels were driven through a softer and more seamy rock than the Hirnant tunnel, and for a portion of their length they are lined with brick. The pipe line is not carried through them. Each of these tunnels is 7 ft. in diameter, and will carry more than the stated flow of 40,000,000 gallons daily. It is interesting to note that Ingersoll drills were used in the hard rock of the Hirnant tunnel.

The Oswestry reservoir, located 18 miles from Lake Vyrnwy, has a capacity of 46,112,000 gallons. It was made by building an earth dam with puddle core across a natural depression. The dam is 1,550 ft. long and 54 ft. in height at the deepest point of the valley. The mouth of the Llanforda tunnel, which discharges into the reservoir, is enlarged to 15 ft. diameter, for what reason we are quite unable to guess.

Most American cities blessed with a supply of water from a mountain lake are quite content to take their water straight, but in England filter beds are the correct thing, and so three-quarters of a mile below Oswestry reservoir three filter beds have been built, and below them a clear water reservoir with a capacity of 2,812,500 gallons. The filtering material consists of a 2-ft. layer of sand resting on a foot of gravel. It is to be noted that the plant at this point is only designed to handle the present supply of 13,000,000 gallons daily; thus when the three lines of pipe are laid there will be nine filter beds and three clear water reservoirs at this point. The walls of the filters and reservoirs are of blue brickwork set in Portland cement. Gages for measuring the flow in the aqueduct are located at this point.

From the clear water reservoir to Malpas tank the pipe line is 16 miles in length. Two railways and several streams are passed under in this distance. The Malpas tank is built of red pressed bricks, and holds only 272,000 gallons. When the other two pipes are laid it is intended to build a 6,500,000-gallon reservoir at this point, and the present tank will be used as a valve chamber to it. From Malpas to Cotebrook reservoir, 11½ miles, is an unbroken stretch of cast iron pipe, all underground. Between Cotebrook and the Norton tower the aqueduct passes under the river Weaver.

The Norton tower is the last one of the "balancing reservoirs." The summit of the hill on which it is located is over 100 ft. below the hydraulic gradient, so a masonry tower was erected, and on top of it was placed a steel tank of 651,000 gallons' capacity. We illustrated and described some details of this tower in our issue of Oct. 10, 1891, and we give herewith a perspective view. The total height of the tower is 115 ft., and it is 82 ft. in diameter. The tank has a curved bottom made up of riveted steel plates, and the sides of the tank are of cast iron. The tension of the curved bottom is taken up by a compression member of steel, which encircles the circumference of the tank. The standpipes by which the water enters and leaves the tanks do not assist at all in supporting the bottom, but pass through it by means of stuffing boxes, and thus do not interfere with the deflection of the bottom. For other details of this tower, reference may be made to our previous description of it, noted above.

The Mersey Tunnel.—From Norton to the distributing reservoir at Prescot is the final section of the aqueduct, 9¼ miles in length; and on this section occurs a work which has caused more trouble and anxiety, on the whole, than any other feature of the enterprise. We refer to the tunnel underneath the Mersey River. The original plan of Mr. Deacon was to cross both the Mersey and the Weaver by laying submerged pipes in a trench, excavated in the river bed, according to a design of his own. This was objected to by the Mersey conservators and the Manchester Ship Canal Co., and the Board of Trade decided that a tunnel must be built underneath the Mersey, which at the point where the crossing is made is 800 ft. in width. The history of this tunnel, which has been from time to time given in these columns, is one of the most interesting in the records of soft ground tunneling. The contract was let in April, 1888, to Messrs. Monk & Newell, for $91,800, the tunnel to be 805 ft. long and 10 ft. in diameter. By the end of 1889 these contractors had sunk the shaft on each side of the river, and had driven 54 ft. of tunnel at a depth of 104 ft. below the bed of the river. The borings had indicated a stratum of impervious bowlder clay at this depth, but, instead, the contractors found quicksand, gravel and other material, which gave free access to the water from above. In December, 1889, the city took possession of the work, and relet it to John Cochrane & Sons, for $73,650, a sum over $40,000 in excess of the first contract price, considering the work done, and the plant and material on the ground. A lawsuit resulted between Monk & Newell and the city, and was referred to Sir John Coode, President of the Institution of Civil Engineers. He awarded the contractors the sum of $72,115, about half of what they claimed.

The most important departure made by the new contractors was to change the level of the tunnel, and begin driving it at a point 62 ft. 9 in. below the water; the change was allowed as the work at the old tunnel level had so disturbed the material as to make the possibility of success there very doubtful. The material at the higher level, however, was sand, silt, gravel and clay, occurring in every irregular way, and heavily water bearing. After expending a large sum in excess of the contract price, and completing only 182 ft. of the tunnel, the senior member of the contracting firm committed suicide, and soon after the city took the work in hand. On Nov. 12, 1891, work was resumed, and in 18½ weeks the shield reached the Cheshire shaft, having made an average progress of 34 ft. per week. The greatest distance driven in any one week was 57 ft. Compressed air was used throughout the work. The shield with which the tunnel was driven was defective in several respects, otherwise more rapid progress could have been made.

The lining of the tunnel is of cast iron plates, after the plan of all tunnels on the Greathead system. The water is carried through it in two lines of 32-in. steel pipes, only one of which has at present been laid. The drainage of the tunnel is collected in a sump at one end, and a pump driven by a water pressure engine lifts it and discharges it into the river.

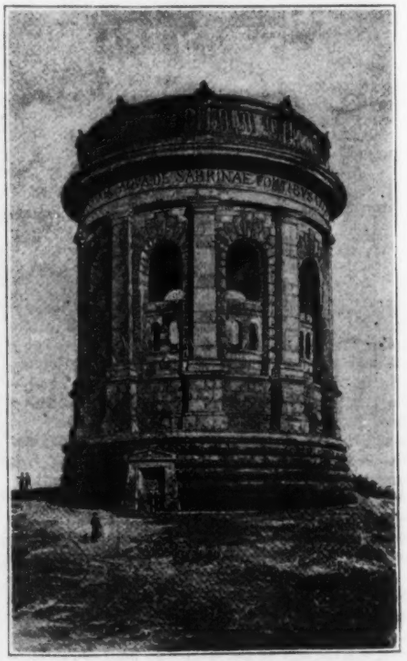


Fig. 4. The Norton Water Tower.

It may readily be understood what a heavy bill of expense would have been saved to the Liverpool taxpayers, and that without hindrance to the navigation of the Mersey, had Mr. Deacon been allowed to pursue his original plan of laying pipes in a trench dredged across the bed of the river. As carried out at the Weaver crossing, this plan was perfectly successful.

The Weaver, at the point of crossing, is 15 ft.

deep and about 100 ft. wide, and the pipes were laid at a depth of 21 ft. Three pipes, each 32 ins. in diameter, were built of mild steel. These were laid side by side, and thoroughly braced together at the works where they were built, and temporary cast-iron covers fitted to their ends. Thus, when launched, these three pipes formed a floating pontoon, 108 ft. in length. This was towed up the river and brought into position over the trench, which had been previously dredged to the proper depth. By admitting water to the central pipe, and supporting the ends of the pontoon by windlasses, the pipes were gently lowered to their place on the bed of the river.

In bracing the three pipes together a rectangular casting was riveted to them near each end. Sheet piling was driven down to a groove in this casting, and then turning was continued to the bank of the river. In this way each end of the pipes was inclosed, and the water of the river cut off. Thus by pumping the water out the connection with the mains on either bank could easily be made. After the pipes were in place, concrete was dumped over them to a depth of about 2 ft. above their tops.

The total cost of the entire work on the Vyrnwy supply, as at present completed, is given as $10,389,640. "Industries" states that the original estimate was $7,577,000, and the estimated time of completion was four years. We believe, however, that the original estimates were for an earth dam of lower height, and they certainly did not include the Mersey tunnel, and probably some other costly works. The only detailed statement of the actual cost that we have seen, was published in "Engineering," Feb. 15, 1889, and was as follows:

Vyrnwy dam and reservoir as above	$3,334,000
Straining tower, valve shafts, valves, culverts, and Hirnant, Cynynion and Llanfordia tunnels	1,514,700
Oswestry reservoir and works	180,618
Malpas reservoir	45,350
Cotebrook reservoir	62,700
Norton water tower	135,374
Mersey tunnel (cost far in excess of this)	110,500
Remaining cost of aqueduct	1,808,860
Filter beds, clear water reservoir, and gages at Oswestry	276,900
Vyrnwy estate not required for works and land at Oswestry for future filters	322,000
Legal and engineering expenses and water damages on streams below dam	457,880
Other lands and easements	836,700
	$9,074,672

For the facts from which the above description is prepared and for the accompanying illustrations, we are indebted chiefly to a large 16-page supplement, recently issued by "The Engineer," devoted to a description of this enterprise, and also to the issues of "Engineering" and "Industries" above referred to.

Car lighting by the Pintsch compressed gas system is being tried on the Madras Ry., India. The gas is made from shale oil, which is crude petroleum, found in Scotland. The gas is compressed to a pressure of 150 lbs. per sq. in., and stored in large steel reservoirs from which it is distributed to smaller reservoirs under each car holding sufficient gas to burn 36 hours. The lamps are fitted with an arrangement by which the conductor can, after the passengers have retired for the night, by pulling the handle of a sliding bar, reduce the flame to a glimmer. The lamps are lighted from the roof, the lighting arrangement being inaccessible to the passengers. There are two lamps in each compartment.

Steel castings are now being made in India, the Government having decided that steel projectiles and ordnance fittings of cast steel must be made in the country. Experiments have been in progress at the foundry and shell factory at Cossipore, and the first steel ingot was cast June 28. According to the "Indian Engineer," the plant consists of a furnace, four gas producers, and a few annealing ovens, drying stoves, etc. The steel is melted by gas supplied by the gas producers. From four to five tons of metal may be melted in one hour. The furnace requires no crucibles to contain the metals. It has a cast-iron bottom, into which is thrown iron and silicon sand, which, being mixed with the slag, forms a hard cake, over which the metal melts. When the furnace is tapped, the molten metal is poured into a 5-ton ladle, which runs over a tunnel, about 5 ft. under the ground level. In this tunnel are arranged the molds, and the metal is allowed to fall into them from a hole at the bottom of the ladle, in quantity just sufficient to fill each mold. There is another contrivance to heat the ladle, consisting of a gas blow-pipe on a large scale. The annealing ovens are also fed by means of gas from the gas producers, and are intended to anneal the castings while in process of turning or finishing. The work has been carried on under the supervision of Capt. R. H. Mahon, R. E.

THE GOUR NOIR VIADUCT.

(With inset.)

The Gour Noir Viaduct, the general plans and details of which we illustrate on our inset sheet, and in the accompanying cuts, is, we believe, with three exceptions (the Cabin John Arch, at Washington, D. C., the Lavaur Bridge over the Agout River, in France, and the Grosvenor Bridge, at Chester, England), the longest span masonry arch bridge in the world. The following table shows the principal dimensions of this bridge, compared with some of the other more important masonry arch bridges in this and foreign countries:

Name and location.	Curve of intrados.	Span, ft.	Rise, ft.	Radius of crown, ft.
Cabin John, U. S.	Circular.	220	57	134
Lavaur, France	"	202	90	102.5
Grosvenor, England	"	200	42	140
Gour Noir, France	"	196.8	52.8	118.1
Ballochmyle, Scotland	"	181	91½	90
Antoinette, France	"	164	52	101.7
*Wheeling, W. Va., U. S.	"	150	28	125.4
London Bridge, England.	Elliptical.	152	29½	102
Elyria, Ohio, U. S.	Circular.	150	27	208⅛
Gloucester, England	Elliptical.	150	35	98

* Nearly completed.

We are indebted to a very complete article by M. Draux, in the "Annales des Ponts et Chaussees," for April, 1892, for the following details and illustrations of the Gour Noir Viaduct:

The viaduct carries the double tracks of the railway line from Limoges to Brive, via Uzerche, over the Vezere River, at a point about 4 kilos. (2.48 miles from Uzerche, in the province of Correze, France. It crosses the river at an angle of 56°, and on a grade of 0.89%. This stream flows through a deep valley, with precipitous, wooded sides, and has a mean width of 40 m. (131 ft.). Its bed has a mean grade of 0.8%, reaching a maximum of 4% in places, and is covered with loose granite bowlders. Owing to its steep grade and precipitous banks the stream is subject to sudden and frequent floods, and at these times its waters carry trunks of trees and floating bodies of all kinds. The difficulty of finding good foundations for piers on this rocky bottom, and the danger from the shocks of floating bodies, both during and after construction, determined the construction of a bridge with a single opening.

The general elevation and sections of the bridge, constructed, are shown in Figs. 1, 2 and 3. It is a circular arch with a span of 60 m. (196.84 ft.) at the springing line. The radius of the extrados is 44 m. (144.3 ft.), and that of the intrados is 36 m. (118 ft.). The rise is 16.1 m. (52.8 ft.). The thickness of the arch at the crown is 1.7 m. (5.57 ft.), and at the springing lines 4.2 m. (13.77 ft.). The total length of the bridge is 109.06 m. (357.7 ft.), and its width between parapets is 8 m. (26.2 ft.). The spandrels are each composed of three "apparent" arches of 4.3 m. (14.1 ft.) span each, the piers of which rest on the main arch, and are pierced with small arches parallel to the axis of the bridges. The flank walls are also hollowed out by three arches of 6 m. (19.7 ft.) span each, as shown in Fig. 1. Connection between these arches is secured by means of openings 1.55 m. (5.07 ft.) and 1.6 m. (5.25 ft.) in diameter, and with the outside by manholes in each of the endmost arches 0.8 × 0.8 m. (2.62 × 2.62 ft.). The spandrels and flank walls are separated by buttresses. To secure firm foundations the abutments are carried down through the loose bowlders to a depth of 4.35 m. (14.25 ft.).

With the exception of the shaft of the parapet, the masonry between the buttresses is of native granite. The plinth, the dentils, the trunk, or coping of the parapet, the archivolts, and the notched seats for the piers of the small arches are of Lonzac granite. The archivolt and ring courses of the main arch are of Gabriol granite. Above the springing line the arch sheeting is of dressed ashlar. The prolongation of the intrados below the springing line (shown darkly shaded in the section in Fig. 1) is also of dressed ashlar for a width of 1.3 m. (4.26 ft.). To the right and left of this zone the masonry of the abutment is of coursed rubble. The buttresses and flank walls are of "ordinary" masonry. All the other masonry is dressed ashlar.

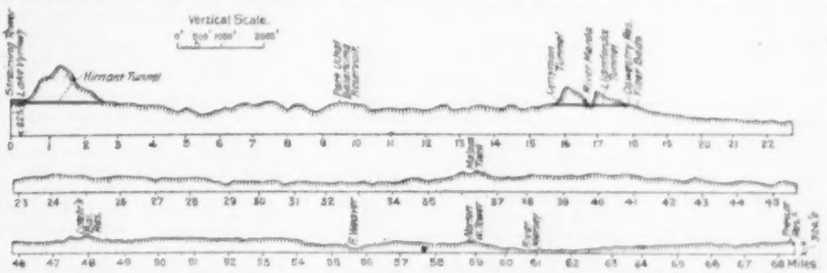


FIG. 5. PROFILE OF PIPE LINE FROM LAKE VYRNWY TO PRESCOT DISTRIBUTING RESERVOIR.

Three different kinds of mortar were used. For the main arch masonry cement mortar, composed of artificial Vicat cement No. 1 and river sand, 650 kilos. of cement* to 1 cu. m. (about 3,000 kilos.) sand. For all the other masonry between the bottom of the foundations and a horizontal line 0.5 m. (1.64 ft.) above high water, and for the piers of the small arches, mortar of Teil lime and river sand 330 kilos. of lime to 1 cu. m. of sand, were used. The remainder of the masonry was laid in mortar of lime and quarry sand, 330 kilos. of lime to 1 cu. m. of sand. All of these mortars were prepared by a grinder with vertical wheels, known as the Deville-Chatel system. The river sand was a coarse grained quartzose sand, dredged from the bed of the river, and the quarry sand was decomposed gneiss, which after washing lost 50% of its volume.

The filling between the haunches of the spandrel arches, or what may be called the spandrel filling of the small arches, is beton; 100 kilos. of lime to 1 cu. m. of sand. Upon this is a coat of hydraulic lime 0.03 m. (1.18 ins.) thick, upon which is a layer of asphalt 0.015 m. (0.59 in.) thick. Just above the asphalt are located the drains 0.2 × 0.2 m. (7.8 × 7.8 in.). The remainder of the filling is of crushed stone.

The center was composed of seven ribs placed 1.56 m. (5.13 ft.) apart, c. to c. An elevation of one of these ribs is shown in Figs. 1 and 2. Each rib was made up of a triangular truss resting on posts set in boxes of sand on the tops of the foundation piles, and supported a system of timbers, carrying the arch timbers and lagging. Longitudinal rigidity was secured by three courses of 5 × 10 ins. horizontal braces. All the joints were covered by sheets of iron 7 mm. thick, and the mortises and tenons with sheets of zinc 2 mm. thick. Washers of iron 0.1 × 0.1 × 0.01 m. (3.9 × 3.9 × 0.39 in.) were used with all bolts. The lagging is of strips of spruce, about 1 × 4 in. × 13 ft. long, tongued and grooved. Eleven piles, eight single and three double, supported each rib; making for the seven ribs, including fender piles, 126 piles. These were of oak with the bark on, and had a minimum diameter of of 0.3 m. (11.8 ins.). The posts resting on the sand boxes, the quoins, and the caps covering the tops of the piles, were also of oak. All the remainder of the center was of spruce.

On account of the character of the bottom it was impossible to drive the foundation piles, and consequently they were shod with iron plates 2 mm. thick, as shown in Fig. 4, and set in holes 0.4 m. (1.3 ft.) in diameter, and about 1 meter (3.28 ft.) deep. The bottoms of these holes were covered with a layer of sand, and the voids surrounding the piles filled with firmly packed cement mortar.

Considerable difficulty was found in sinking these holes. At first it was thought that they could be bored under water by means of the Lippman ap-

* For the first 20 courses of voussoirs, however, the proportion of cement was increased to 800 kilos.

paratus, and work was begun, but on account of the hardness of the rock, causing frequent breakages, and the difficulty of keeping the tubes in place, this method was abandoned, except for the softer parts. All the other holes were cut by stone cutters with hand drills. This necessitated the drying of the bottom, and, consequently the construction of coffer-dams. Taking advantage of the fact that the river is roughly divided into three channels, three coffer-dams were constructed, beginning with the south, or Brive, channel. The general arrangement of the coffer dams is shown in Fig. 5.

The upstream walls of the coffer-dams were composed of two courses of 50 mm. (2 ins.) sheet piles, spaced 1 m. (3.28 ft.) apart. Each course of sheet piling was secured by double braces at the top and bottom, held together with bolts, and the two courses were also connected by drift bolts. A plan and a cross-section of one of these walls are shown in Figs. 6 and 7, and a plan of the braces holding the sheet piling in Fig. 8. The space between the two courses of piling was filled with clay mixed with chopped straw. The down-stream walls of the dams, a section of which is shown in Fig. 9, were constructed in the same manner, except that the sheet piling was only 1.18 in. (30 mm.) thick, and the two rows were spaced 0.6 m. (1.96 ft.) apart. These walls were secured to the shores by gudgeons, and were supported at the center by four steel bars, 2½ in. diameter, set into the rock. In addition to these, small square iron bars, 2×2 in., were driven into holes drilled into the rock 2 m. (6.56 ft.) apart. The general arrangement of these bars or iron piles is shown in elevation in Fig. 10, and in plan in Fig. 5 and 8. Subterranean currents were stopped, as shown in Fig. 11. These secondary coffer-dams were necessary only in two cases.

As will be seen from Fig. 12, the main arch above the 20th course of voussoirs on each side was built in three rings, and each ring in several segments.* The inner ring, or that nearest the intrados, was divided into eight sections, the middle ring into six and the outer ring into eight. Each section was separated from the other by masonry, laid with dry joints.

Work on the arch masonry was begun Dec. 19, 1888, and the first 20 courses, or that portion of the arch built in a single ring and designed to support the buttresses, were completed in 2 mos. 3 days. To prevent the mortar from running out onto the faces of the voussoirs, strips of oak were placed in the joints. This was also done in all joints with the exception of those without mortar, where strips of lead were used. Before beginning the masonry above the 20th courses, or of that portion of the arch constructed in three rings, the center was loaded with a surcharge of stone equal in weight to the first ring to fully settle all joints, so that when the masonry was begun, account would have to be taken of the distortion of the wood only. Under this load the center settled 8 mm. (0.31 in.) at the crown. After the removal of the load the upstream side of the center rose 3 mm. (0.12 in.), but the down-stream side remained stationary.

The 21st course of voussoirs was begun March 10, and the next four courses on each side were laid with dry joints. Above these joints the masonry was supported by struts, as shown in Fig. 13. There were 10 of these systems of struts placed 0.9 m. (2.95 ft.) apart. Between the first and second sections the supports were constructed as shown in Fig. 14, and for the other two sections as shown in Figs. 15 and 16. The first ring was completed, with the exception of the removal of the braces and the keying, on April 17. The daily progress of the work for the whole arch is shown in Fig. 17. The keying was begun April 18. The mortar used in this work was ground and sifted in seives having 24 meshes per c m. A caulking instrument espcially designed for the purpose, was used to force it into the joints. The systems of braces were removed, and the arch keyed in the order shown in Fig. 12, the work being finished May 4. Work was then begun on the second and third rings, which were completed June 5 and Aug. 5, 1889, respectively. Great care was used in all of this work, both in placing the voussoirs, each one of which was numbered, and to keep the mortar of the same consistency.

Before striking the center the completed arch was loaded with a surcharge of 175 cu. m. (227 cu. yds.), of stone, spread over the entire upper surface of the arch. This load remained during the striking of the center.

It was at first planned to leave the masonry on the center 90 days before striking, but as this would bring the date of this operation on Nov. 6, when the cold weather would interfere with the laying of masonry, it was decided to shorten the time. Consequently, the center was struck on Sept. 28, or 52 days after the completion of the masonry. Great pains were taken in this operation, and especial care used to record the amount of settlement.

As before stated, the posts of the triangular truss forming a portion of the center were set in boxes of sand, which were provided with holes from which the sand could be drawn, allowing the center to sink. One of these sand boxes with the apparatus attached for determining the settlement is shown in Fig. 18. A is the lower chord of the truss, and B the plates supported by the foundation piles, upon which the sand box rests. The scale (a), graduated in millimeters, is attached to the post resting on the sand, its zero coinciding with the edge of the box. To B is attached another scale, also graduated in millimeters, containing a groove in which slides a tongue attached to A, which just before beginning to remove the sand was marked at a point coinciding with the zero on the scale.

At the crown of the arch, and at the angles of 15° and 35° with the vertical, the apparatus shown in Fig. 19 were attached. The upright, R, provided with a cutting edge of iron, was attached to the masonry. The cutting edge rested upon the short arm of a lever, the long arm of which terminated in a point traversing a vernier, G, graduated in millimeters. The lever was adjusted to show a reading four times as great as the actual depression. Fig. 19 shows clearly the arrangement of the lever and the upright. The wooden frame supporting the lever was attached to the temporary bridge built at the side of the new structure, as shown in Fig. 20. In addition to these apparatus, instrumental readings of the settlement were also taken.

The men at the sand boxes were provided with graduated measures into which the sand was drawn and also with the apparatus necessary to remove and replace the plugs. Men were also stationed at various points to take the readings, and to watch for the appearance of any fissures. During the operation all traffic was stopped on the temporary bridge, and every precaution was taken to have the conditions as perfect as possible.

The records of the operation as taken were briefly as follows: Only a very small settlement was shown until the height of the sand in the boxes had

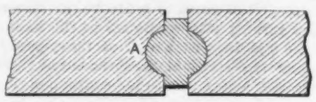


Fig. 27.

been decreased 3 mm. (0.118 in.), when the levers showed a settlement at the crown of 0.5 mm. (.0197 in.); at the angle of 15°, 0.4 mm. (.0157 in.); and at the angle of 35°, nothing. After a decrease of 7 mm. (0.275 in.) in the height of the sand, the center was detached from the arch. The levers showed at this point a settlement of 1.1 mm. (.0433 in.) at the crown, of 0.7 mm. (.0275 in.) at the angle of 15°, and of nothing at the angle of 35°. A slight settlement took place after the separation of the center from the masonry, making the total settlement at the crown 1.3 mm. (.051 in.), at the angle of 15°, 0.8 mm. (.031 in.), and at the angle of 35°, 0.3 mm. (.0118 in.).

The remainder of the masonry, which was begun soon after striking the center, presented nothing worthy of special mention. The general arrangement of the plant used in the work is shown in Fig. 20.

Some novel observations of special interest were made by the engineers, however, in regard to the effect of temperature upon the arch. Owing to the small number of available data in regard to this

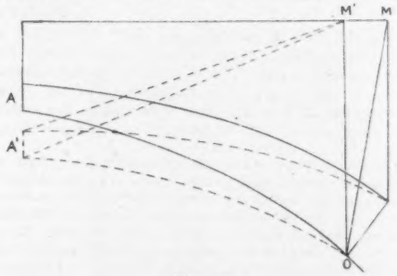


Fig. 28.

well known phenomenon, and the especially favorable opportunities afforded by a structure of this size for their study, we give the facts collected nearly in full, although they are much less fully discussed than could be wished. The author of the present article has paid especial attention to the matter, however, and proposes to discuss it more fully at a future time. The author's remarks concerning the dilatation of the masonry in the Gour Noir Viaduct, slightly abbreviated, are as follows:

The dilatation of the masonry can easily produce very sensible differences in the position of the crown of an arch. I have often been able to verify this phenomenon in my own work as well as that of others. In long spans, despite the care taken in the placing of the plinth and in the jointing, I have often ascertained that the winter following the joints of the parapet were broken above the piers. At the Bramefond Viaduct (on the St. Denis line to Buisson) the parapet, which was constructed in soft stone, was bound with iron clamps, and in the joints between the several panels circular orifices were carefully arranged as shown in the accompanying cut (Fig. 27), into which cement was run, so that after this operation the parapet formed practically a monolith. This work was done in July and August, that is to say, at the time of the greatest warmth. At the beginning of the following winter small fissures were noticed, starting at the foot of the parapet and proceeding along the joint nearest the plinths. Some of the panels were broken. Constant

Table Showing Progress of Work, Cost of Labor, etc., etc., on Main Arch Masonry of Gour Noir Viaduct.

		Masonry in main arch.				
	Foundations, 1,031 cu. yds.	First 20 courses, 406 cu. yds.	First ring, 770 cu. yds.	Second ring, 592 cu. yds.	Third ring, 421 cu. yds.	Whole arch.
Date of beginning work	Oct. 25, '88.	Dec. 20 '88.	March 10, '89.	May 5, '89.	June 28, '89.	Oct. 25, '88.
Date of completing work	Dec. 19, '88.	Feb. 22, '89.	May 4, '89.	June 5, '89.	Aug. 5, '89.	Aug. 5, '89.
No. of sections	....	....	8	8	8	24
No. of keyings	....	....	21	5	5	31
No. days actual work	44	28	37 (1)	28 (1)	39 (1)	176
No. days delay	3	28	16	6	6	59
Total days	47	56	53	34	35	235
No. days actual work keying	....	....	14	4	1	19
No. courses masonry laid per day, actual work	0.53	0.72	7.59	10.04	7.2	2.06
Cu. yds. masonry laid per day, actual work	23.42	17.3	20.8	21.12	10.8	18.7
Cu. yds. masonry laid per day per mason	1.92	1.4	1.35	1.34	1.06	1.38
No. hours work of mason per 1 cu. yd. masonry	5.2	9.32	7.42	7.43	9.43	7.27
No. hours work of common laborers per 1 cu. yd. masonry	13.12	7.1	12.55	11.60	10.04	12.62 (2)
No. kilos. cement per 1 cu. m. masonry	299	202	144	212	160	215 (2)
No. masons employed per day	12	16	13	15	10	14
Cost of hand labor per 1 cu. m.; material on centre	$1.71 (3)	$2.44 (3)	$2.06 (3)	$1.97 (3)	$2.38 (3)	$2 03

(1) These figures include the time employed in keying. (2) In these figures the laborers employed in making the mortar and and to serve it to the masons are inclued only. (3) In these figures are included days' work of the machinists, the foreman of the timber yards, the masons and the laborers for making and carrying the mortar.

* This system of construction is quite common in France, especially for long span arches. The Antoinette and Lavaur arches were both constructed in this manner. The advantages claimed are, that the construction in rings admits the use of very light centers, and the building in segments localizes the inevitable cracks resulting from settlement on the centers.

observations were made and it was established that these fissures existed only in the parapet and plinth, and that they increased with the decrease in the temperature. At certain times they attained a thickness of 3 mm., and at other times, during the summer following, they were imperceptible.

These movements observed in viaducts being met with in all works and notably in retaining walls of great length, I have in order to obtain proof of them, placed in the horizontal joints of one of the longest of my walls very thin plates of glass, placed vertically and just filling the joint; the edges touching the upper and lower stones. At the coldest part of the winter these plates were all broken although they remained intact during the summer. This phenomenon can evidently be explained only by the energetic contraction of the mortar, and, consequently, a settlement, small

"apparent" arches, which were erected. Now upon the sinking of the large arch 12 mm. this winter, fissures were produced in the spandrels at the points of least resistance and greatest strain, that is to say, at the crown of the two arches nearest the buttressees. As will be seen from Figs. 23 to 26,* the fissures increase from a minimum at the intrados of the small arches to the extrados and thence to the parapet, so that above the small arches the masonry is held only by the adhesion of the mortar, which therefore needs to be excellent.

We at first thought to fill these fissures with pulverized mortar as we did the dry joints, but on second thought this appeared likely to be more injurious than beneficial. For supposing the fissure OMM1 filled, then the heat returning, the point A1 tends to approach A., and either to cause crushing in M1M, or else to

depression at the crown, then, will a contraction of 0.015157 correspond? Here, evidently, we are obliged to make a supposition, for we do not know what the new curve will be, even supposing that the arch after removing the center was an exact circle. But admitting that the new curve may be an exact circle a calculation gives for the diminution of height 0.0115. Referring to the diagrams, (Fig. 3), we see that our settlement for a difference of temperature of 20°, for example between Oct. 20, 1890, and Jan. 17, 1891, is practically 0.012 m.

The author gives detailed tabular statements of the quantities and cost of the several parts of the work, from which we republish accompanying table showing the progress of work as of general interest. The total cost of the structure was 335,000 fr.. or

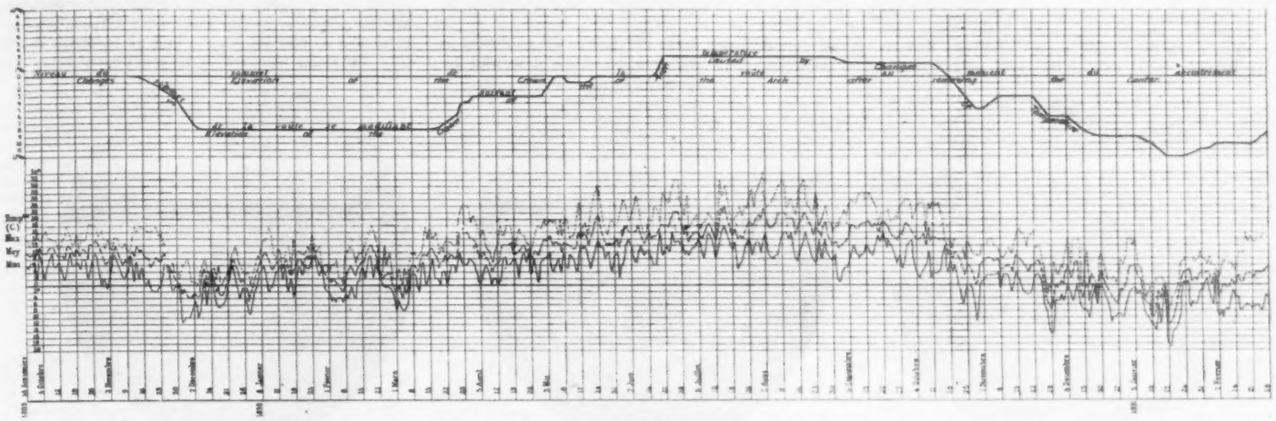


FIG. 29. DIAGRAM SHOWING MOVEMENTS OF CROWN OF ARCH FOLLOWING THE VARIATIONS OF TEMPERATURE, GOUR NOIR VIADUCT.

it is true, but actual, of all the mass. This settlement is elsewhere clearly shown by the cracking of certain vertical joints.

At the Gour Noir Viaduct dilatation was to be foreseen and, considering the magnitude of the work, movements of considerable amplitude were to be expected; and actually occurred. Thanks to the particular care employed in the construction of the arch we were not able to discover during the striking of the center the least trace of a fissure in the large arch. As for the crown of the arch it remained at the same level while the temperature of the masonry remained quite high, but, on the contrary, as soon as it began to lower the arch began to move, and during the period of quite low temperature of the winter of 1889-90, during which the thermometer descended to 10° F., the top of the arch sunk gradually 10 mm. At this point it remained stationary until spring when it began to raise little by little, to return to its original position in the month of June, 1890. In October the sinking began anew and rapidly increased, following the particularly rigorous frosts of 1890-91. This time the total sinking was 12 mm., instead of 10 mm. as observed in 1889-90. It is certain that, the heat returning, the arch will begin to rise again, and that about the month of September it will return to its original position. This movement of the large arch did not alter it in any manner, however, and no fissures were manifested either at the haunches or at the crown. Unfortunately it is not the same at the spandrels. It is easy to see from the accompanying diagram (Fig. 28), that when the top of the arch A descends to A1, a fissure will be produced in the spandrels. This fissure from nothing at the great ring reaches its maximum at the top of the parapet, and in the Gour Noir Viaduct during the exceptional winter of 1890-91, the maximum, MM1, was 2.5 mm. Like results can be observed in all masonry bridges, but it is apparent that in large bridges the amplitude of the movements will be greater.

We have observed this movement, especially at the Brezou Viaduct (radius of intrados 17.5 m.=57.4 ft.), and we show in Figs. 21 and 22 the position of the fissures in this structure. In the Brezou bridge, however, as in most masonry bridges, the fissures in the spandrels offer only slight inconveniences, for the spandrel is in effect only a supporting wall. A vertical fissure can divide it into two parts, but then there are two supporting walls instead of one, and each is sufficient to resist, each on its side, the forces which affect it.

At the Gour Noir Viaduct, we at first proposed to use plain, unbroken spandrel walls with the roadway supported by longitudinal arches. This simple and severe design appeared to us to be most in harmony with the nature of the crossing and the abrupt and precipitous banks of the river. Nevertheless our proposition was rejected, and the administration imposed upon us six

open a fissure reversed from the first and greater toward the larger arch. Everything considered, we preferred the fissure OMM1, the inconvenience of which appeared the least.

From what precedes upon the dilatation of large arches we draw the following conclusions: (1), hollowing out the spandrels by transverse arches ought to be abandoned. When it is considered necessary to use them it will be advisable to lay the masonry of these small arches with the greatest care, and to use a good proportion of cement for the mortar, for the time will arrive in the winter when the arches nearest the abutments will break at the crown so that each half of the arch will be sustained only by the adherence of the mortar.

(2). For the same reason it would be advisable to take very small radii for these arches; the pointed arch would perhaps be a solution.

(3). The best plan would be to use plain spandrels with or without hollow interiors; in the last case, using longitudinal arches exclusively.

I intend, however, to consider this question of the dilatation of masonry in a future article. For the present, considering only the Gour Noir Viaduct, I content myself with giving a diagram (Fig. 29), indicating the movements of the large arch following the variations of temperature. I may add, in addition, that these movements are verified by calculation, as will be seen from the following:

The mean length of the arch along the curve from one foundation to the other is 83.66 m. From this the sum of the widths of the joints, 369 in number, is to be deducted. These joints have a thickness of 0.025 m. at the face of the arch, but as their thicknesses are greater toward the center, and as it is necessary to take some account of the transverse joints, it does not seem an exaggeration, despite all the care taken in the construction, to adopt a mean thickness of 0.04 m.; making for the 369 joints, 14.76 m. This leaves then for the length of the granite 68.9 m.

This granted, if we consult the work of M. Claudel and the article of M. Bouniceau in the "Annales" for 1863 we find the figures for the coefficient of dilitation quite discordant. We have taken for cement mortar the coefficient 0.000014 and for granite the coefficient 0.000008. The contraction of the arch under a difference of temperature of 20° C. would then be:

(14.76 m. × 20 × 0.000014) + (68.9 m. × 20 × 0.000008)= 0.015157.

The two springing lines being fixed and the arch shorter it is necessarily depressed at the top. To what

about $67,000. The plans were drawn up and the work carried out under the direction of the general inspectors. MM. Doniol and Rousseau. The engineers who drew the plans and directed the work were M. Daigremont, Chief Engineer, and M. Draux, Assistant Engineer.

MOVING THE DRAW SPAN OF THE MACOMB'S DAM BRIDGE.

An engineering work of some interest was carried out a few weeks ago in the removal of the draw span of the old Macomb's Dam Bridge over the Harlem River, New York city, which was briefly referred to in our issue of Aug. 4. The old bridge has been closed and removed to make way for the new high level bridge at 155th St., which was described and illustrated in our issue of May 26, and a plan given at the same time showing the location of the old and new bridges. The old span is to be placed at a new site further down the river, to serve as a temporary bridge, and it was therefore desired to move it bodily. As shown by the accompanying views, it is a center pivot bridge, with the ends supported by guys or stays from the central tower. Cribs were built on two barges which at low tide were floated one on each side of the pivot pier, and were then secured together at the bows. The rise of the tide lifted the bridge about 4 ft. above the pier. The barges were then towed clear of the pier, the sterns secured together and braced apart to keep the cribs in position. The bridge was then towed across and a short distance down the river where it was swung parallel with the stream and lowered to a temporary pier until the new pivot pier for the temporary bridge is completed, when the span will be placed upon it in the same way. We are indebted to Mr. Robert L. Harris, Am. Soc. C. E., for a set of kodak photographs showing the different stages of the work, from which we have selected the three views shown in the accompanying cuts. Fig. 1 shows the bridge partly moved off the pier, which is partly hidden by the pile driver. Fig. 2 shows the bridge being towed across the river. Fig. 3 shows it being lowered to place on the temporary crib pier. Mr. Harris describes the work as follows:

Sir: It is well known to your readers that you appreciate early accounts of incidents in the engineering world, and your promptness in illustrating accidents and deriving lessons therefrom is commendable. An incident, which was without the slightest accident, how-

* Figs. 23 and 24 show the left end spandrel arch; Fig. 23, the down-stream face, and Fig. 24, the upstream face. Figs. 25 and 26 show the right end spandrel arch; Fig. 25, the down-stream face, and Fig. 26, the upstream face.

ever, was witnessed by me to-day (July 27), and as a kodak was convenient, the button was pressed with results that may interest your clientage.

The drawbridge of the Macomb's dam bridge across Harlem River was lifted from its pivot pier in a position transverse to the channel, moved a few hundred feet on the river and then deposited on a temporary pier in a position parallel to the channel.

The bridge will next be lowered several feet by the aid of the tides and will then rest awhile until the low pile pivot pier of the temporary bridge is ready to receive it, when it will be moved there in a similar manner.

The views so clearly show the arrangement and the movement that words seem superfluous. Cribs of square timber were built on two barges, each of which had a boom derrick. At low water these were floated under the swing-span, one on each side of the pivot pier, their bows being held apart by a timber and tied together by a hawser. As the tide rose the span was

Fig. 1. Moving the Bridge Off the Pivot Pier.

Fig. 2. Towing the Bridge Across the River.

Fig 3. Lowering the Bridge Onto the Temporary Pier.

MOVING THE DRAW SPAN OF THE MACOMB'S DAM BRIDGE; HARLEM RIVER, NEW YORK.

lifted above the pier some 4 ft. A line from a pile driver hoisting engine towed barges, bridge and a rear pile driver until clear of the pier, when a timber strut and hawser tie were placed to hold the sterns of the barges in position, the ends of the span being guyed to the bows and sterns of the barges. A rear holding line was made fast to a pier of the old Macomb's dam bridge. The assistance of a single tug was then rendered and the bridge was carried to the temporary resting place.

The time that elapsed between the final drawing of the center pin and the putting of the bridge in position to take its temporary place at the lowering of the tide was about one hour (12:45 to 1:45 p. m.) Everything worked smoothly and successfully and reflected great credit upon the contractors, Messrs. T. & A. Walsh, of 114 Wall St. Among the many witnesses were several New York civil engineers.

A great deal of interesting work is going on in that vicinity, especially in relation to the completion of the 155th St. viaduct and the beginning of the new "Central Bridge" across the Harlem River (which is to take the place of the Macomb's dam bridge), the substructure of which is by Contractor Herbert Steward, as recently shown in your journal. The place is well worth a visit.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Injury of Passenger on Crowded Trains.

In an action against a railway company for injuries received by a passenger, the evidence showed that plaintiff was injured while standing on the platform of a moving car; that the cars were crowded full; that when he got on the train he first attempted to enter another car, and yielded his place to some ladies; that at a station between the one where he took the car and the one where the accident occurred, 75 or more of the passengers left the train; and that plaintiff did not after their departure attempt to enter another car. The testimony did not show that plaintiff could have entered any car if he had tried to do so. Under these circumstances a verdict for the passenger will not be reversed on account of contributory negligence. (C. & A. Ry. Co. v. Fisher, Supr. Ct. of Ill., 31 N. E. Rep., 407.)

Liability for Turntable Injury.

A boy 13 years old and of ordinary intelligence, while playing on a turntable, which he and other boys had put in motion, allowed his feet to project over the end, and they were crushed between it and the embankment on which the tracks were laid to the turntable. He said he knew that it was dangerous to let his feet project over as he did; and that if he had thought of the danger he could have avoided it; but that he was having fun, and did not think of it. The boy was under the circumstances guilty of contributory negligence, and could not recover for his injuries. (Merryman v. C. R. I. & P. Ry. Co., Supr. Ct. Ia., 52 N. W. Rep., 545.)

THE NEW WATER-POWER AND WATER SUPPLY AT AUSTIN, TEX.

As we have noticed from time to time, the city of Austin, Tex., has undertaken and carried well toward completion a great and important enterprise in the development and transmission of power. A masonry dam 60 ft. in height is being built across the Colorado River, and over its face a volume of water amounting to from 200,000 to 250,000 cu. ft. per second will have to pass in time of flood. The enormous amount of water which this represents may be appreciated by remembering that the flow over Niagara Falls is about 275,000 cu. ft. per second. The depth of the water which will flow over the crest of the dam at the highest stage is estimated to be 15 ft.

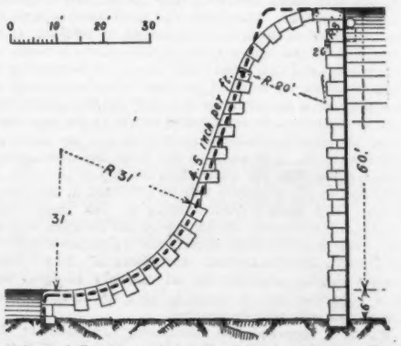
In our issue of July 11, 1891, we published a cross-section, map, and elevation of this dam, and described some of the principal details of the enterprise as then arranged, as reported to us by Mr. J. R. Frizzell, Chief Engineer. A report on the dam and power house, and on the water and electric supply systems, has recently been made by Mr. J. T. Fanning, Consulting Engineer, in which he recommends a modification of the profile of the dam, and the use of penstocks instead of a canal for conveying water to the power house. In view of the great activity in the development of water power at the present time, Mr. Fanning's report is of much interest. We reprint it as follows:

On inspection of the new dam in progress, in company with the Board, I was impressed with the magnitude of the engineering work, and especially with the exceeding great responsibility which the city has committed to the Board. I find that the dam which you have projected will raise the water of the river 60 ft. above the former low water level, that it will have a maximum height to its crest of 70 ft., and that its crest overfall will be about 1,125 ft. long, and that the dam will flow the water 25 miles up the valley, creating an extensive lake.

This dam is being constructed of solid masonry, and is faced on each side with large blocks of excellent granite. Not for its length alone, or its great area of flowage, is the dam remarkable, for in France we observe three longer masonry dams, at Buzey, Chazilla and Gros Bois, 1,545, 1,759 and 1,805 ft., respectively, and in Wales the Vyrnwy dam, 1,350 ft. long, the latter being for the storage reservoir of the Liverpool water supply. Not in height alone, for in France there are three dams, in Spain two, in Belgium one, and in the state of California one masonry dam exceeding 150 ft. in height. There are 14 other notable masonry dams having heights exceeding 100 ft.

But none of these dams are upon great rivers, and very few of them have any water pass over their crest. On the other hand, the Austin dam stands in the channel of the Colorado River, where it has 40,000 sq. miles of water shed, and will have floods of 200,000 to 250,000 cu. ft. of water per second to pass from its crest to its toe. Your citizens will appreciate your responsibility when they learn that no dam in existence has to pass a volume of water, in flood, even approximating this, through so great a height. Limestone and sandstone yield rapidly to the eroding force of falling water. The evidences of this are abundant in the canyon of the Niagara River below Niagara Falls; of the canyon of the Genesee River below Genesee Falls; of the Mississippi River below St. Anthony Falls; and here, of the Colorado River across Travis Co., as well as in the channels of numerous streams that flow down each of the Rocky Mountain slopes. Such evidences admonish us that this great flood must not be permitted to have sheer fall through so great a height and act with a destructive force such as has heretofore created canyons, but it must be made to glide down the slope of the dam and not be permitted to exert the force due to its velocity except at such distance below the dam that the foundations will not be endangered.

The profile of the dam shown to me seemed not to fulfill the required conditions for passing the floods, because of the slightly rounded or nearly angular form at the front of its crest. The diagram accompanying shows an advised modification of the profile of the upper part of the dam, which is better adapted to pass the flood in a gliding sheet down the face of the dam, and to deliver it to the lower level without a direct blow, and so that its velocity will be expanded chiefly in a horizontal direction in the backwater below the dam, and in eddies at a safe distance below the toe of the dam. The lower part of the down-stream face of the dam has a curve of 31 ft. radius, to which low water surface is tangent. The central part of this face has a batter of 4.5 ins. to the foot. The new profile at the top part, as suggested, completes the down-stream face and crest of the dam with a curve of 20 ft. radius, to which both the front batter and the surface of the pond at a level of the crest are both tangent, this curve ending on the crest at 5 ft. from the upper angle of the crest. The upper angle of the crest is then rounded off with a smaller curve, and the entire front of the dam becomes a reversed curve of ogee form, the form of dam best of all adapted to pass a large volume of water through so great a height. The top curve conforms nearly to the theoretical form of a medium flood



Section of Dam on Colorado River at Austin, Tex., Designed by J. T. Fanning, Consulting Engineer. Estimated Flood Discharge Over Face of Dam, 250,000 Cu. Ft. Per Second.

(Profile of dam as originally designed, shown by a dotted line.)

stream. At higher flood stages there will be a tendency to vacuum under the curved stream immediately after it has passed the crest, which, together with the pressure of the atmosphere upon the top of the stream, will keep the full flood stream in close contact with the curved face of the dam, and cause even the highest flood to glide down the fall without shock upon the face of the dam or the soft rock foundation.

The Power House.—I have carefully examined the several plans suggested for the location of the power

house and pumping machinery. The natural features of the river canyon must to a considerable extent control the location of the power house. The southerly rocky bank of the river is steep, and about 150 ft. high. The northerly rocky bank is steep, and about 60 ft. high. The banks are about 1,150 ft. apart. The curve of the river has caused the low water channel and the swiftest part of the current in flood to heretofore keep close to the southerly bank, and to make a return eddy next to the northern bank that deposited sands as the the flood receded. This sand deposit occupied about 400 ft. in width of the northerly side of the channel and has been from 40 to 50 ft. in depth, forming a bench at near flood level. The effect of the level, long overfall of the dam will be to shift this deposit during the next few floods for 300 to 500 ft. distance in front of the dam, and to form an additional deposit a short distance lower down the river. Because of these probable changes, I do not think it wise to locate a power house on the site of the sand deposit within limit of its changeable action, and furthermore, as the foundations of the power house ought to be down upon the rock, it is advisable to use the rock bed on the stable northerly shore and out of the canyon as far as possible. A granite revetment facing on the northerly canyon wall, forming a return wall for a distance of 250 ft. down stream from the toe of the dam will be a necessity to protect the unstable lime rock wall of the canyon from undercutting by the powerful eddies in floods near the foot of the dam. This revetment will make a good foundation for the river wall of the power house, the other walls resting on the top of the ledge. The best location for the discharge of water from the wheel pits will be at the site of this revetment and near the toe of the dam, for the channel will be always open here, and the wheel pits will not be in danger of back flooding by deposits, as might be the case a few hundred feet lower down the river. The permanency and usefulness of the power house will be best assured in this location.

It is quite important that the waters to be used for pumping the city supply and for the electric lighting of the city and power shall be taken to its turbine wheels entirely separate and independent of other water that may be used for general manufacturing purposes, so that it shall not be subject to any of the contingencies of drawing off the canal or pipes of the manufacturers, or to the new works, extensions or repairs of the manufacturers' plant. I have therefore planned the penstocks and gates for the pumping and lighting plant as a separate and complete system. During great floods, when there is 15 ft. of water on the crest of the dam, the backwater will reduce the effective head below the dam 40 ft., and if the additional head upon the dam is not made useful, the pumps and electric machinery will be stopped until the flood recedes. Penstocks from the dam to the turbines in the power house are therefore a necessity, so that in such case the entire fall may be used, and the effective fall will be reduced from 60 to 35 ft. only, instead of to 20 ft. The turbines and gearing will be adapted to meet this contingency.

The size of the power house and its penstocks is governed by its probable work. It is probable that soon after the completion of your works the mean daily consumption of water will be from 2,500,000 to 3,000,000 gallons, with an excess of at least 50% during those certain hours of the summer days when the draft will be strongest. One 4,000,000-gallon pump would be ample for this quantity of water consumed for domestic purposes in the city. For fire service each good hose stream will throw water at the rate of 333,000 gallons in 24 hours, and as a large fire might require not less than 15 streams at one time, this would make an addition to the domestic consumption of a rate of 5,000,000 gallons in 24 hours. It is possible that a fire might happen at a time when the reservoir was temporarily shut off, and both the domestic and fire service would come from the pumps direct. It is also advisable to have a duplicate of the pumping machinery. These considerations lead me to suggest two pumps for the city water supply of 4,000,000 gallons capacity for 24 hours each, and that both of these be so arranged that they can be used for direct pumping service if occasion requires. I propose that each pumping machine with its vertical turbine be entirely independent of the other, and at the same time to so arrange them that they can be coupled to work in concert, or that their parts may be interchangeable, and perform interchangeable work. Each of these pumping machines will require 185 net HP. and together they will use 370 HP., and use for power 74 cu. ft. of water per second.

In computing power for the electrical division of these works, it is assumed that the street lighting will generally be by incandescent lights rather than arc lamps. I estimate that 1,000 of such lamps of 25-c. p. each may be required within a few years, and that these will require a power equivalent to that for 1,562 lamps of 16-c. p. For the domestic lighting, I estimate that the city has approximately 5,000 dwellings, and that the lamps for these will equal five each for one-third this number of dwellings, or 8,333 lamps; that the commercial lighting and public institutions and city departments will require the equivalent of 6,000 lamps of 16 c. p. I estimate that 408 HP. of electrical plant should be provided for the street railway, and for general mechanical work in the city, for small powers generally.

This domestic, commercial and department electric lighting may be done, say, by ten dynamos of capacity each to supply 1,200 16-c. p. lamps, and the street lighting by two dynamos, each equaling in capacity the above described. The street railway and other mechanical work may be done by four generators of 120 HP. each. I propose that the 16 generators above described be arranged in groups of 4, each group to be driven by a pair of horizontal turbines, and that the turbines be so adapted that these groups can be temporarily subdivided again if occasion requires, or they may be driven as three-fourths, one-half, and one-fourth, as well as full groups. Each pair of turbines will be of 506 HP. capacity, venting 97.5 cu. ft. of water per second. The total power will then be:

For pumps, two vertical wheels, 370 HP., venting 74 cu. ft.

For incandescent lamps, three pairs of horizontal wheels, 1,518 HP., venting 292.5 cu. ft.

For mechanical work, one pair of horizontal wheels, 506 HP., venting 97.5 cu. ft.

The above will require six wheel pits, and I suggest that one extra wheel pit be provided for electrical works and one for the water supply machinery.

The sum of the power herein indicated for the water supply pumping, electric lighting and electrical mechanical work, is about 2,400 net HP. But the maximum work of lighting lasts only about three hours each day, say 7 p. m. to 10 p. m. The maximum street railway work will be about 1½ hours in the morning, again near noon, and again from 5 p. m. to 6:30 p. m. The pumping work can be done when the other work is lightest, so that 2,400 HP. of maximum work will be accomplished with less than two-thirds this maximum, or say about 1,500 HP. of mean work, requiring about 275 cu. ft. of water per second for the power. The extreme low water flow of the river seems to be about 700 and the ordinary flow of water about 1,000 cu. ft. per second, and there will therefore be ordinarily 725 cu. ft. of water available for other purposes, or an equivalent of 3,950 net HP. for constant work, or upward of 9,000 net HP. for ten hours per day work, and a larger power when the river flow is above an ordinary low stage.

To allow for this ten hour use of the surplus water, five penstocks extend from the head gates to opposite the easterly end of the power house, from whence they may be continued, or the water conducted in a canal according to the requirements of the manufacturers. The penstocks are deemed the safest and most feasible method of conducting the water into and past the power house and relieve the power house of possible dangers of leaks and ruptures of canal banks and stoppages of the works. The 1,000 extra HP. will do a large amount of mechanical work, as, for instance, 100 HP. is sufficient for a large machine or implement shop; 450 HP. will run a cotton mill with 50,000 spindles, on cloths adapted to this local jobbing trade, and 400 HP. will run a wheat flour mill of 1,000 barrels capacity, or an equivalent corn meal mill.

Settling Basin.—An available site on which a settling basin may be constructed, except at great cost, is not found near the pumping station, as would be desirable. The "Lake McDonald" created by the great dam will at nearly all seasons make an admirable settling basin owing to its length of 25 miles, its great depth and large section and slow velocity of the stream through it when the total flow of the stream does not exceed a rate of 1,000 cu. ft. per second. But during flood, when the flow is 200,000 cu. ft. per second, the water in the lake will be changed eight or more times per day instead of once in 20 days, as at ordinary flow. It is quite desirable to have a source of clear water to draw from when the river is carrying considerable sediment, as it often does. The positions where a settling basin of sufficient capacity may be most economically constructed, are on the hills one to one and a half miles southwesterly of the dam, and several available sites are found there. These several basin sites are at an elevation of about 300 ft. above the level of low water in the river below the dam. Either one of these basins is high enough to serve also as distributing reservoirs, such as will at times be found very useful if none other is provided, such as a tank standpipe for instance within the city. When these sites are considered from a sanitary standpoint they will be classed as about equally desirable natural storage basins, and nearly all that could be desired of natural basins, except that their rocks are calcareous instead of siliceous. They have but little soil or vegetation, are without population on their water-sheds, and are remarkably free from natural sources of pollution. Comparing these sites by volumes of storage, the Brackenridge site, near the head of the little Bee Creek water-shed, is found to have fifty per cent. greater storage capacity than the others for an equal expenditure, that is, a storage of 75,000,000 gallons, as against 50,000,000 at the other sites. Comparing these sites for ready accessibility during construction, availability of earths and stones for construction of the embankment, least height and greatest safety of the embankment, best locations for force main from the pumping station and ease of approach for inspection and care when in use, we find the advantage to be with the Brackenridge site. The adoption of this site is therefore advised.

The total height of the embankment is 52 ft. and its length at the top 540 ft. Across the valley, from foundation to above water line, there is in the heart of the embankment a core-wall of water and vermin tight masonry. The embankment will otherwise be made of adobe earths, gravel and stones, which the basin will supply. In the embankment above the core-wall is a gate and screen chamber, circular in plan, twelve feet internal diameter. The effluent pipes are four in number, placed at different heights above the base of the reservoir, so that the water may be readily drawn from different depths, as the changes of the seasons and the sedimentary conditions of the water may show to be desirable. The influent pipe is at the lower level and extends far up into the basin so as to promote the greatest possible changes of position in the water, and prevent tendency to stagnation. As spawn of fish will be sent up from the river by the pumps, the reservoir will be in time amply stocked with fish. Screens of fine copper wire are provided in the well-house, to prevent the fish from entering the pipes. The screens are arranged to slide in grooves so they may be readily removed, cleaned and replaced. The valves of the influent, effluent and waste pipes are placed in the well-house, and a waste valve is provided for draining the well-house, so that its valves and screen frames may be accessible.

A force main of 24 ins. diameter is provided from the pumping station to the settling basin. If this main only is used, the water from the basin to the city will return past the pumping station by this same main. As the pumps are working, water may flow either into the city or to the basin. The surplus of water pumped and not used in any given short period will flow to the basin. When a second main can be afforded from the pumps to the basin, all the water pumped may be first sent into the basin, as will often be desirable.

Mr. Fanning then discusses the arrangement of the distribution system. He proposes to divide the city into large rectangular sections by distributing mains of large diameter, and gridiron each of these areas by 6-in. pipes. Replying to questions asked him as to the influence of this great water power on the development of the city, he declares that it will be worth all it costs merely as a means of pumping the city's water supply and furnishing it with electric light. If suitable encouragement is given to judicious manufacturing enterprises, he considers great advantages will accrue to the city.

The expenditures to June 1, 1892, have been $421,309, of which $300,548 has been paid to Mr. Bernard Corrigan, the contractor for the dam; $82,723 has been paid for the railway and street grading, and about $38,000 has been expended for engineering and general expenses. The following is the estimated cost of completing the entire works:

Completing dam as per engineers' estimate.		$250,080.00
Expense account and surveys of land		30,000.00
Head gates and return wall		30,000.00
Power house and tail race		60,000.00
Iron penstocks, valves and racks		60,000.00
Turbines and pumping machinery		45,000.00
Reservoir, valves and screens		60,000.00
Force main and pipe distribution		305,000.00
Amount already expended as above		421,309.43
		$1,261,309.43
Balance available for electric plant		183,609.57
Received for 900 bonds sold	$875,000.00	
Bonds unsold, 500 at par	500,000.00	
Value of motor railway	70,000.00	
	$1,445,000.00	$1,445,000.00

WORLD'S COLUMBIAN EXPOSITION.

Electric and Steam Launches.

The concession for running electric launches on the lagoon and grand canal has been awarded by the executive committee to the Electric Launch & Navigation Co., of New York, after having had competitive tests made of the launches proposed to be used by different bidders for the concession, as noted in our issue of May 26. The company is to run 50 boats, making 12 landings on the round trip, and will pay the exposition management 33⅓ per cent. of its gross receipts. During the tests this company's boat "Electra" made 45 trips at the rate of 11¼ minutes per trip. A concession has been granted to Willard & Meeker, providing for the operation of steam launches upon certain waterways

of the exposition, the grantees to bear the expenses and pay to the exposition 25% of the gross receipts. The course to be covered by these boats starts at the grand basin opposite the Manufactures Building; thence through the outer lake into the north lagoon, stopping at a point near the Fisheries Building, and return over the same course; also around the piers and into the lagoon south of the Agricultural Building, and return to the point of starting.

It is proposed to have three styles of boats running: omnibus boats, which will have considerable seating capacity, and will make regular trips over a prescribed route, stopping at specified landings at each building; express boats which will make the round trip of all the lagoons without any stop; and cab boats, which will have a capacity for perhaps six people, and which, like a street cab, can be hailed anywhere and at any time, and are at the service of visitors. Of the electric launches the "Electra" was offered by the Electric Launch & Navigation Co., of New York, and the "Volta," by the Columbia Launch Co., of Chicago. The tests of steam launches is very generally understood. of the electric boats, from the fact that the efficiency of the steam launches is very generally understood. In the case of the electric launches, however, each was given a very thorough test, then supplementary to this the electrical department of the fair gave each battery an exhaustive test. First the boats were tested, bags of sand weighing 140 lbs. each being used to represent passengers. The tests were for ten consecutive hours, and included endurance, smooth running, tilting angle when all the passengers were on one side of the boat, freeboard under such conditions, sea room requisite to turn round, distance required to reach a full stop, etc.

The "Electra" has an oak frame, planked with Spanish cedar, and the interior finish is mahogany. It is fitted with electric incandescent lamps and signal lights. It is 34 ft. long, 6 ft. beam, with a maximum draft of 26 ins., and will comfortably seat 25 or 30 passengers. The boat was designed to carry 78 storage battery cells, but only 62 have been used during the tests. These cells are of the Consolidated Electric Storage Co.'s type, and they are coupled in series of 31 each, and these in parallel. The propeller is 18 ins. in diameter with 12-in. pitch. The motor is of the Reckenzaun type of 4-HP. capacity, but capable of developing 12 electrical HP. at "spurting" or the highest speed, which is nearly 12 miles an hour. When running at full speed the battery gives an effective current of some 33 amperes at about 60 volts. The electrolyte is gelatinous, thus obviating any danger of spilling. In addition to the 50 boats of this class it is probable that the company will provide 20 smaller boats, of a similar design, 20 ft. long, seating 10 or 12 persons comfortably. These will be let out by the hour to private parties, families, etc. Mr. C. H. Barney is general manager of the company.

The Columbia Launch Co. entered two boats, the "Volta," designed for service either as an omnibus or express launch, and the "Daisy," intended only for a cab boat. The "Daisy" can seat six people comfortably, is 18 ft. long, 4½ ft. beam, contains 24 cells, and is run by a Jenney motor of 1½ HP. These boats are finished in mahogany, with oak frame. The "Volta" is 36 ft. long, 7½ ft. beam, and has a seating capacity for 32 people. It was provided with 104 cells of the Morrison type, made by the American Storage Battery Co., Chicago, and it has a 5-HP. Jenney motor. The armature of the motor is connected direct to the shaft, and when running at highest speed makes 700 revolutions a minute. This boat has been running for some two months, and has attained a speed of 10 miles an hour, although in the lagoons the management made a limit of about 5 miles an hour. The boat is lighted by four incandescent lamps, and also has colored signal lights. The batteries are under the floor, while the motor is out of sight in the stern, and none of the mechanism can be seen except the lever for controlling the current and the steering apparatus.

Progress of Work.

It is stated that all the main buildings will be inclosed by Sept. 1, and that the Manufactures Building will be completed in time for the dedicatory ceremonies in October. The contractors for the steel arch roof trusses of 368-ft. span, the erection of which was described and illustrated in our issue of July 28, have moved the derrick to the north end of the building. There remains three weeks' work in placing the gable trusses at the north end, which will complete the iron work on the building. The carpenters are closely following the iron workers. On the Machinery Building (Eng. News, June 30) iron work is completed except the central towers, and all other contractors on the building have their work well advanced. The terminal railway station is not yet begun. Grading and tracklaying are progressing rapidly for the terminals, and the Illinois Central R. R. is actively at work elevating its tracks along the western boundary of the park, past the entrances. The corrugated iron roofing of the dome of the U. S. Government Building is being set, and the exterior staff covering is being placed at the base of the dome. The hull of the battleship "Illinois" is completed, the decks are being laid, the plumbing work is under way and the iron work for the bridge deck and superstructure is being placed.

Over 13 miles of underground pipe were laid during July. The dredges excavated 90,000 cu. yds. of sand and clay from the lagoon bottoms, and have nearly finished their work. There were 71,000 sq. yds. of roadbed graded and graveled, and roads and paths were finished to the extent of 42,000 sq. yds.

State buildings have sprung up in the north part of the grounds with great rapidity. There are 23 of these in course of erection, and more than half of these are nearly completed. The framing of the Illinois State Building is complete, except the dome, which is being erected. The interior plastering is nearly finished, and the exterior covering is well under way.

Work will begin soon on the big pier into Lake Michigan. The contract has been let to Hiero B. Herr & Co., for $158,000, for the construction of a pier 2,500 ft. long and 250 ft. wide, extending from the shore into deep water. The contract calls for its completion Oct. 15. A contract has also been made with Culbert & Tutz for the building of a pier 800 ft. long, extending from the site of the Great Britain Building, and alongside of the battleship. It will cost about $21,890. The force employed on the grounds is 8,200 men. Of these, contractors employ 5,900, and the exposition management 2,300.

PERSONALS.

Mr. John T. Shea has been appointed Superintendent of Water-Works at New Lisbon, O.

Sir Daniel Wilson, President of the Toronto University, died at Toronto, Ont., Aug. 7, after a protracted illness.

Mr. Otto Schroll has been appointed Engineer of Maintenance of Way of the Wheeling Bridge & Terminal Co., Wheeling, W. Va.

Mr. George W. Dixon has been appointed Superintendent of the Pittsburg, Marion & Chicago Ry., with headquarters at New Lisbon, O.

Mr. Grenville C. Cunningham, formerly City Engineer of Toronto, Ont., has been appointed electrical engineer for the Montreal Street Ry. Co.

Mr. H. W. Edwards has been appointed Engineer of Maintenance of Way of the Western Division of the Great Northern Ry., with headquarters at Spokane, Wash.

Mr. James L. Frazier, formerly Superintendent of the Western Division of the Newport News & Mississippi Valley R. R., has been appointed Division Superintendent of the Southern Pacific Ry., with headquarters at Fresno, Cal.

Mr. H. F. J. Porter, for the past year First Assistant Mechanical Engineer of the construction department of the World's Columbian Exposition, has been transferred to the National Commission of Machinery, and appointed Assistant Chief Engineer under Lieut. L. W. Robinson, Chief of Machinery Department.

Mr. A. R. Raymer has been appointed Assistant Engineer of the Michigan Southern Division of the Lake Shore & Michigan Southern Ry., with headquarters at Toledo, O., vice M. W. Cooley, resigned to take the position of Engineer of Maintenance of Way on the Toledo & Ohio Central Ry., with headquarters at Bucyrus, O.

Mr. Wm. W. Crehore, formerly connected with the Wallis Iron Works and other bridge companies, has opened an office as civil and mechanical engineer at 25 Pine St., New York, N. Y. He will make a specialty of bridge and structural iron work, including strain sheets, bills of material, specifications and drawings, and will also undertake the inspection and superintendence of work. He is a son of Mr. J. D. Crehore, the author of "Mechanics of the Girder."

Prof. George T. McLaughlin, of the Massachusetts Institute of Technology, was drowned at Lynn Beach Aug. 14. He had the misfortune to be an excellent swimmer and attempted to swim out to a raft anchored several hundred feet off shore, but was seized with cramps. His brother, who was with him, swam to the raft and, after waiting for his appearance, returned to the shore, only to find his dead body just being taken from the water. Prof. McLaughlin was about 25 years old, and was a man of brilliant promise.

Mr. Hugh Riddle, Chairman of the Executive Committee of the Chicago, Rock Island & Pacific Ry. Co., and ex-President of that company, died Aug. 10 at Chicago, Ill. He was 70 years of age, having been born in August, 1822, at Bedford, N. Y. At the age of 24 he became a member of the engineer corps of the Erie R. R., and from 1851 until 1869 he was identified with the operating department of that system. In the latter year he went to Chicago as General Superintendent of the Chicago, Rock Island & Pacific Ry. In 1871, he became Vice-President of the company, and in 1877, he was elected President, serving in that capacity until 1883. He was associated with Mr. Charles Francis Adams on the Trunk Line Committee in 1884, and in 1885 he was elected a director of the Union Pacific Ry.

Mr. Benjamin G. Clarke, one of the leading men in the iron and steel industry of this country, died Aug. 12 in Antwerp, Holland, aged 72 years. Mr. Clarke was President of the Thomas Iron Co., of Hokendauqua, Pa.; Vice-President and Chairman of the Executive Committee of the Lackawanna Iron & Steel Co., and the Lackawanna Iron & Coal Co.; President of the New Jersey Zinc Co., and a director in the Mount Hope Mining Co. of New Jersey, the Tillie Foster Iron Co. of New York, the Franklin Iron Co. of New Jersey, and other iron manufacturing or mining companies. He was also a director of the Delaware, Lackawanna & Western R. R. and other railroads. He was born in 1820 near Easton, Pa., and was all his life engaged in the iron trade. He was one of the pioneers of the industry in Pennsylvania.

Gen. William Petit Trowbridge, the head of the Engineering Department of the School of Mines, Columbia College, died in New Haven, Conn., Aug. 12. Gen. Trowbridge was born in Oakland Co., Mich., May 25, 1828. He entered the U. S. Military Academy at West Point, in July, 1844, and four years later was graduated at the head of his class and promoted Second Lieutenant in the Corps of Engineers. He acted as Assistant Professor of Chemistry in the last year of his course at the Military Academy, and the two years immediately following his graduation he spent in making astronomical observations in the Military Observatory at West Point, in preparation for duty in the U. S. Coast Survey, to which he was ordered at his own request. In 1850-51 he was attached to the company of sappers, miners, and pontoniers, and in the following year, 1852, he was assigned to duty under Alexander D. Bache, and engaged in the primary triangulations of the coast of Maine, the entire work being subsequently placed in his charge. Surveys of the Appomattox River, in Virginia, and of the James River, near Richmond, with a view to the improvement to navigation, occupied his attention for the two succeeding years, in the course of which he also surveyed the Dutch Gap and recommended the "cut-off," or canal, which was subsequently constructed. From 1853 to 1856 Gen. Trowbridge conducted a series of surveys of the Pacific Coast, including astronomical, tidal, and magnetic observations. These observations extended along the Pacific Coast from San Diego to Puget Sound.

He was promoted to be First Lieutenant of the Corps of Engineers Dec. 18, 1854, and resigned his commission Dec. 1, 1856, to accept the chair of Professor of Mathematics in the University of Michigan, which he held for a year, when at the request of Prof. Bache he accepted the office of Scientific Secretary of the Superintendent of the U. S. Coast Survey, and was engaged in the preparation for publication of the results of the Gulf Stream exploration.

Gen. Trowbridge was ordered to Key West in 1860 to superintend the erection of a permanent self-registering magnetic observatory. In the following year he prepared charts containing minute descriptions of the harbors, inlets, and rivers of the southern coast for the use of the navy, and subsequently made a hydrographic survey of a part of Narragansett Bay, R. I., where it was proposed by the government to erect a navy yard.

Gen. Trowbridge served in the Union Army through the civil war. At the outset of hostilities he was placed in charge of the Engineer Agency in New York City, the province of which was the supplying of material for fortifications, and the constructing and shipping of engineer equipage for the armies in the field. Later he was the superintending engineer of the construction of the fort at Willet's Point, of repairs of Fort Schuyler, and of works on Governor's Island, New York Harbor.

He returned to civil life on the close of the war, and for the four years following 1865 he was the Vice-President of the Novelty Iron Works, New York. He was elected Professor of Dynamical Engineering in the Sheffield Scientific School of Yale College in 1870, where he continued until 1877 when he was called to the charge of the Engineering Department of the School of Mines of Columbia College, which post he held at the time of his death.

He was a commissioner of the State of Connecticut for the building of the new capitol at Hartford and of the city of New Haven to establish harbor lines and to build a bridge across the Quinnipiac River. The degree of A. M. was conferred upon Gen. Trowbridge by Rochester University in 1856 and by Yale University in 1870; of Ph. D. by Princeton University in 1880, and of LL. D. by Trinity College in 1887. He was the Chief Special Agent of the tenth United States census for collecting statistics relating to "Power and Machinery Employed in Manufacturers." Gen. Trowbridge was a member of many scientific societies and Vice-President of the New York Academy of Sciences and of the American Association for the Advancement of Science. In the latter capacity he presided over the section of mechanical science in 1882, and was elected to the National Academy of Sciences.

SOCIETY PROCEEDINGS.

ENGINEERING ASSOCIATION OF THE SOUTH.—At the regular meeting in Nashville, Tenn., Aug. 11 Mr. J. S. Walker presented a paper on "Locks and Dams;" Mr. W. B. Ross described the Seaton automatic electric railway block signal, and Prof. W. W. Carson's paper on "A New Treatment of the Mississippi River Problem" was discussed.

Olin H. Landreth, Secy.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.—The annual convention will be held at Detroit, Mich., Sept. 14. Mr. Robert McKeon, of Kent, O., is secretary. The following subjects will be discussed. Would it be practicable for railway companies to adopt the piece price system in the paint department upon railroads, and if so, what plan and schedule would you suggest for doing the work so as to cover all classes and parts of paintshop work upon locomotives and cars? What is the best method of making putty for passenger car work, speed and durability combined, and is it advisable to use any coloring with lead in mixing hard drying putty? In what manner should the outside surface of a passenger car be treated that has a good foundation, but requires recoloring, and should the varnish be removed before recoloring. If so, how? In what manner should requisitions for material in the railway paintshop be made to best observe the interests of the management; economy and suitable material being the main consideration? Which are the most durable, light or dark colors, on passenger car bodies? Which is the least expense to maintain, yellow, Pullman color or Tuscan red? What plan and material can be recommended to improve upon the general appearance of the equipment while in service and also increase its durability? What is the difference in cost of painting a passenger coach with yellow, Pullman color or Tuscan red?

The following queries will also be presented: 1, Do you paint your engine frames with color and then varnish them, or do you use asphaltum; 2, how do you clean the paint and varnish from glass; 3, in touching up and revarnishing a coach, is it economy to thoroughly clean and touch up the deck and trucks, or to paint them over; 4, how do you use gold and copper bronze for seat arms, heater pipes, etc., dry or mixed; 5, which is the best gilding size, slow or quick; 6, in cutting in a coach with color, do you use it mixed in the same way as when giving a general painting; 7, do you give the sashes the last coat of varnish before or after they are put in; 8, has any member ever found a paint remover that he felt sure would not injure the wood or subsequent painting?

THE INSTITUTION OF MECHANICAL ENGINEERS.

(From our London Correspondent.)

The Institution of Mechanical Engineers held its annual summer meeting at the historic town of Portsmouth on July 26 to 29. The south coast of England does not afford much field for research on the part of the mechanical engineer, but in the Royal Dockyard at Portsmouth there is a center of attraction which is altogether unique. Portsmouth is now the oldest dockyard in the kingdom, since its senior at Woolwich was closed in 1869. In a map published, showing the growth of the yard, we find that a small piece of the existing area is put down as "date unknown." This is probably the part which, Mr. White tells us, was ordered by the Sheriff of the County of Southampton, to be inclosed with a wall in the year 1212. Mr. White claims that Portsmouth Dockyard is the oldest in existence. Probably he has warranty for his statement, but we were under the impression that the arsenal at Venice was more ancient. There is in England a private shipbuilding yard which has an antiquity not far inferior to that of the royal yard at Portsmouth. This is Blackwall yard on the Thames, from whence ships for the Royal Navy have been launched almost since the reign of Queen Elizabeth. In the year 1540 the total area of Portsmouth Dockyard was 8 acres; in 1850 it was 115 acres; it is now nearly 300 acres. In 1864 two inclosed basins of 14 acres and one of 22 acres were added, besides a tidal basin of 10 acres. During the current financial year the sum of £854,230 is to be spent at Portsmouth on construction of ships. At present 7,500 men are employed.

The mechanical engineers assembled in the Town Hall on July 26, Dr. Anderson, the President, in the chair. The papers to be read were as follows:

"Shipbuilding in Portsmouth Dockyard," by Mr. William H. White, C. B., F. R. S., Director of Naval Construction and Assistant Controller of the British Navy; "The Applications of Electricity in the Royal Dockyards and British Navy," by Mr. Henry E. Deadman, Chief Constructor, Portsmouth; "The Lifting and Hauling Appliances in Portsmouth Dockyard," by Mr. John T. Corner, R. N., Chief Engineer, Portsmouth; "The New Royal Pier at Southampton," by James Lemon, Esq., J. P., Mayor of Southampton; "The Portsmouth Sewage Outfall Works," by Sir Frederick Bramwell, Bart., D. C. L., LL. D., F. R. S., Past-President; "The New Floating Bridge Between Portsmouth and Gosport," by Mr. H. Graham Harris, of London; "The Southampton Sewage Precipitation Works and Refuse Destructor," by Mr. William B. G. Bennett, Borough Engineer and Surveyor; "The Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experiment Works, Haslar," by Mr. R. Edmund Froude, of Haslar.

All the papers were read but the last, which in many respects was the most interesting of all. Neither the Royal pier at Southampton, the Portsmouth outfall works, the floating bridge, nor the sewage works and refuse destructor at Southampton possess any features of special novelty, although all are doubtless meritorious engineering works. Mr. White's paper was of interest chiefly from the historical point of view. He gives particulars of 14 typical ships built at the dockyard between 1859 and 1892. This takes us back to the old screw three deckers, which of course were all of wood. The "Victoria" was the largest three-decker ever built at Portsmouth, and was launched in 1864. She was 260 ft. long, 60 ft. 1 in. wide, and nearly 7,000 tons displacement. The horse power was 4,200 indicated and the speed 12½ knots. She carried 102 guns, one being a 110-pdr. Armstrong. The "Royal Sovereign," our latest and most powerful line of battle ship, is 380 ft. long, 75 ft. wide and 14,150 tons displacement. Her indicated horse power is 13,000 and her speed 18 knots. She carries 14 guns, 4 of them weighing 47 tons each. She has steel faced armor of 18 ins. thickness. The chief differences between the "Victoria" and the "Royal Sovereign" do not appear in this comparison, the former vessel having the towering sides of a three-decker, and the lofty spars above, nearly all her guns being fought through ports on the broadside. In the "Royal Sovereign" there are but two military masts, which will not carry sails and the principal armament is carried in barbettes. There is yet another striking difference, which appeals strongly to the average British tax payer. The "Royal Sovereign" (and she has seven sisters) cost about $5,000,000, all told, for material only; but if we include the cost of the officers and crew, the cost to the country is about $15,000,000. That is to say, it would cost about that sum to rebuild the ship and train her personnel to their duties. The cost of the "Victoria" without armament and stores was only $1,100,000, which was about three times the cost of a 100-gun line of battle ship (sailing of course) of the beginning of the century, and about twice that of the 110-gun sailing line-of-battle ship of 1840. Roughly it may be said that the price of line-of-battle ships has advanced ten-fold within the present century, so that for the sum we now are paying for the 8 battle ships on the present programme we could have built a fleet of 80 in the days of Nelson.

The paper by Mr. Deadman gave some interesting details of electricity as employed in the navy. It is generally supposed that the application of electricity to practical uses is the business of the engineer, but in the British Navy there are many and strange uses, and the naval architects having got hold of the electric business, appear determined to keep it, whether they understand it or not. If we are to believe Mr. Crompton, the eminent English electrical engineer and contractor, the latter is the case. According to that authority, and he is one that cannot be ignored, the British Navy is behind all others in electrical matters. That is not a pleasant thing to hear, but it is better it should be made known in time.

Passing to Mr. Corner's paper, there are two principal ways of distributing power at Portsmouth, namely, pneumatic and hydraulic. Electricity has not yet entered the field. Mr. Corner says that compressed air affords the best vehicle for the purpose, from the fact that it lends itself to working expansively. If the motors could always be worked up to their full power, water would be the best. The air is compressed to 60 lbs. per sq. in., and at that pressure there is no trouble from frost being formed during expansion. In very damp and cold weather frost or snow does form to some small extent, but the exhausts are open and it all passes away. There are two miles of hydraulic pipes varying from 1½ to 4 ins., and about 2⅝ miles of air pipes, varying from 3 to 12 ins. in diameter. The air receivers have a capacity of 18,000 cu. ft. There are a large number of cranes, etc., worked by their own steam engines in the usual way. An abstract of this paper was given in our issue of Aug. 11.

The excursions were successful on the whole, the weather being perfect throughout. The visit to the dockyard was well attended on the first day, although, in one respect, it was unfortunate, as nearly all the ships had been mobilized, and were away for the summer maneuvers. On the second day a visit was paid to the Portsmouth sewage works where the chief novelty was the sluices opened by the accumulated sewage itself, to be liberated and discharged into the sea. A number of turbines were arranged to be worked by the unsavory fluid, which, nevertheless, seems to perform the function very well.

The victualing yard for the navy was also visited on this day. On Thursday, July 28, an excursion was made to Southampton, where the new piers and the docks were inspected. Visits were also paid to the Union Steamship Co.'s repairing works, and the London & Southwestern Ry. car shops, at Eastleigh. The latter has been recently constructed, the department having been removed from London to this rural district in Hampshire. The new works are commodious and well laid out, but do not possess any special features of novelty. Perhaps the chief point of interest is the fact that pressed steel under-frames for freight cars and truck frames of the same kind for passenger cars are finding much favor on this line. Where one considers the strength and simplicity of the solid old trough formation, one can only wonder that the timber and composite structures do not give way more rapidly in favor of the newer construction. In other respects, the London & Southwestern, like other British line, keeps fairly well within conventional lines in the matter of passenger and freight equipment.

On Friday there was a steamer trip round the Isle of Wight. That was very pleasant, none the less, so that it had not even a semblance of business. On Saturday some of the members went to Brighton, on their way to town, to visit the Brighton locomotive works of the London, Brighton & South Coast Ry.

COMING TECHNICAL MEETINGS.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Aug. 18. At Atlanta, Ga. Secy., F. A. Charplot, Macon, Ga.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Aug. 20. Secy., F. D. Jones, Helena.
NEW ENGLAND ROADMASTERS' ASSOCIATION.
Aug. 24, 25. Springfield, Mass. Secy., G. L. E. French, Northampton, Mass.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Sept. 2. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Sept. 2. Secy., O. von Geldern, 319 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Sept. 3. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Sept. 3. Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 3. 1122 Girard St. Secy., L. F. Rondinella.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 7. Secy., F. Collingwood, 127 East 23d St., New York
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Sept. 8. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Sept. 8. Secy., O. H. Landreth, Nashville, Tenn.
WISCONSIN POLYTECHNIC SOCIETY.
Sept. 12. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Sept. 12. Secy., C. L. Annan.
NEW ENGLAND RAILROAD CLUB.
Sept. 13. Secy., F. Curtis, B. & A. R. R., Boston.
DENVER SOCIETY OF CIVIL ENGINEERS.
Sept. 13. Secy., Geo. H. Angell.
NORTHWESTERN SOCIETY OF ENGINEERS.
Sept. 13. Seattle, Wash. Secy., E. H. Warner.
MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC.
Sept. 14. At Detroit, Mich. Secy., Robt. McKeon, Kent, O.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Sept. 15. Secy., C. F. Franson, 118 Adams St.
ENGINEERS' CLUB OF CINCINNATI.
Sept. 15. Secy., J. F. Wilson.
WESTERN RAILWAY CLUB.
Sept. 20. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., R. N. Clark, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.
CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Macbeth.
ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 18. Chattanooga, Tenn. Oct. 19. Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.
AMERICAN STREET RAILWAY ASSOCIATION.
Oct. 19, 20, 21. Cleveland, O. Secy., Wm. J. Richards, Brooklyn, N. Y.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 21, 22. Roanoke, Va. Secy., J. R. Schick, Roanoke.

ENGINEERING NEWS

AND

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CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The new national eight-hour law which we commented on last week in its relation to government shops seems likely to have a most important and injurious bearing, which can hardly have been intended, on river and harbor works and perhaps also on the government surveys. According to the plain wording of the law as given last week, no laborer or mechanic can be even permitted to work more than eight hours in any one calendar day, without rendering the contractor or government official so permitting it liable to fine and imprisonment. Every contractor who intends to undertake river and harbor work will have to estimate as best he can the effect of this new law. Every government engineer, too, will have to take the law into account in making out his estimate of time required to complete work, as well as his estimates of cost, where estimates are still to be made. It is easily realized what a difficult task this must be, for there are no precedents to guide one in judging of the effect of shorter hours, either on the cost of labor or on the rate of progress of work. As one effect of the law many proposed new contracts are being re-estimated and re-advertised.

As an example of how things will be upset by the law, it is known, of course, that a careful estimate has been made of the cost, and of the time required for completion of every piece of work for which the present River and Harbor bill authorizes contracts to be made. In every case where these estimates are correct, we may expect the actual time and expense of construction to be considerably increased. We sincerely hope that no blame will be laid upon the engineer because his estimates prove far out of the way under these circumstances.

It is not alone employees of contractors that will be affected by this law, but all laborers employed by engineers on government work. In some cases the working of the law may be very injurious. For example, take the case of an engineer out on a river reconnaissance, where he has to be gone from camp 12 to 16 hours. Must he take two crews of boatmen along, and work them "double turn?" Or take the field parties of the Coast and Geological surveys. The season for work is exceedingly short, and long hours on good days are the rule, and a necessity for reasonable progress. Can the law be evaded on the plea that the mule drivers, axemen, and similar classes of necessary helpers are not laborers?

It really seems that if Congress had more carefully considered the matter they would have restricted the operation of the law to workmen engaged in shops, mills, factories, or the yards adjacent thereto. Many of the Congressmen who spoke in favor of the bill referred to the long working hours of the farmer, and said that they were not really onerous in this case, since his work was subject to the vicissitudes of the weather and the seasons, and during a large part of the year he was necessarily idle. They failed to realize, however, that the same thing is true in a greater or less degree of all outdoor work, and is true in a very great degree of the Government work on surveys, and of much of the contractors' work on rivers and harbors. Bad weather often keeps the men idle, sometimes for days at a time, and when good weather comes, the common-sense policy seems to be to "make hay while the sun shines."

A principal argument for an eight-hour working day, and one which must have much force with every humanitarian, is that the additional hours of leisure will give workingmen more opportunities for self-improvement; more leisure for the pleasures of home life. But these arguments have little force as regards the class of work of which we are speaking. The men are gathered in camps far from their homes and families, and with no opportunities to improve their leisure time, were they ever so much disposed to do so. The most of them are only anxious to earn the most money in the shortest possible time, and get back to civilization. They have all too much leisure during the winter months. To compel them by law to pass from two to four hours of each day of their working season in idleness is very far from doing them a kindness.

The forestry bill noted in our issue of Jan. 9, seems to have received such favor as to have a good chance of passing the next Congress. Mr. Paddock's bill, which is to provide for the establishment, protection and administration of public forest reservations, embracing the object sought by the American Forestry Association, received the approval of the Senate Committee on Agriculture and Forestry, was favorably reported to the Senate, and, though action upon it could not be secured in the closing days of the late session, it has been placed upon the calendar of the Senate to be called up at the first opportunity in the next session. The measure is a most desirable one, providing for an examination of all public lands bearing forests and covered with timber, or undergrowth. Plans of such lands are to be filed in the General Land Office, after which the President is by proclamation to set apart as forest reservations all these lands, with the exception of such as are found to be more valuable for general agriculture than for forest uses and forest culture. The object of this legislation is to protect and improve the forest cover within the reservations, for the purpose of securing favorable conditions of water flow and continuous supplies of timber to the districts within which the forest reservations are situated. Government regulation and management of forests, to prevent the waste and reckless destruction of timber, and to provide for the cutting of trees under proper conditions, and the planting of trees so as to maintain the forest and insure a continuous commercial supply of timber is carried out with great success in Europe, India, etc., and forms a source of revenue to the governments. We fear it will be a long time before it will do so in this country, but this first step in that direction is undoubtedly a good one. The bill provides for the appointment of a Commissioner of Forests in the Department of Agriculture; one inspector and two assistant inspectors of forests, a superintendent of each forest reservation, and an assistant superintendent for each reservation of over 1,000,000 acres, together with rangers to act as police to prevent trespass, fires, illegal cutting of timber, etc. The cutting of wood will be done under license or permit. The opening of mines, construction of irrigation works, roads, etc., within the reservations, are provided for in the bill.

THE VYRNWY WATER SUPPLY FOR LIVERPOOL.

Elsewhere in this issue we give a full illustrated description of the works constructed in connection with the new water supply for the city of Liverpool, England, an enterprise entitled to rank among the great engineering works of this century. Though in cost far less important than the new Croton aqueduct tunnel ($10,000,000 against $30,000,000, in round numbers), and carrying only 13 to 40 million gallons per day against 100 to 318 millions, the engineering features of the Vyrnwy works are far more interesting and varied.

It is really surprising as one studies this work to notice the wide gulf that exists between English and American ideas and customs as to water supply, with the resulting great difference in the plans adopted. In very many respects we must in candor admit that the English methods are superior; but in many other particulars the American engineer can congratulate himself that he is more nearly up with the times, and is less hampered by precedent in his work than is his British cousin.

To a water-works superintendent the most striking difference between the dwellers in American and English cities is that the latter will get along on from a half to a third the quantity of water per capita that is considered necessary in this country. The explanation of this is that potable water is getting to be a scarce article in densely populated England. The rivalry between the great cities to secure the best water-sheds in the mountainous districts of England and Wales is already very strong. Even far-away London is jealous of Liverpool's enterprise in securing possession of the Vyrnwy valley, for the great metropolis has for a long time looked toward the Welsh mountains as the only possible source of a large and pure future supply.

This scarcity of water is also the explanation of another fact which seems strange to an American engineer, viz., that Liverpool utilizes at present only one-third of its available supply from Lake Vyrnwy, and continues the use of its old supply of inferior quality which was partly pumped from driven wells and partly taken from a small river. An American city which had gone 77 miles to secure an abundant supply of water flowing by gravity from a mountain stream would be very apt to cease the use of its old supply when the new was introduced, and would moreover increase its consumption as fast as possible. Those in charge of the Liverpool water-works are fortunate that public opinion permits them to pursue a wiser course. They are looking far into the future, and realize that to introduce the whole available supply from Lake Vyrnwy now would soon result in the extravagant use of water, a habit which is extremely difficult to eradicate when once established. If American experience is a criterion, the day when both the old sources of supply and the flow from Lake Vyrwny will be inadequate for Liverpool's population is much farther away than if the whole flow from the latter had been made available at once.

The most important feature of the whole enterprise from an engineering point of view is the great dam, which has been the subject of more controversy than all the rest of the work, if we exclude the Mersey tunnel. Had an American city had the work in hand we may be pretty sure that no such cyclopean structure as that which holds back the waters of Lake Vyrwny would have been built. Perhaps the original plan of an earth dam with a masonry heart wall would have been adhered to. Considering the possibility of excavating rock from the hillsides and dumping it in the valley at very small cost per cubic yard, there is reason to believe that an earth-backed rock fill dam with or without a masonry heart wall could have been built on the site of the Vyrwny dam which would have been equally strong with the present structure, and would have cost not half as much.

It is true that most engineers are loth to approve any material but masonry for very high dams, but it is rather uncertainty concerning the impermeability of an earth dam than actual knowledge of its weakness that leads engineers to distrust it, and some one with everything to win and nothing to lose in the way of reputation may yet build a great dam of earth which will stand as safely as any masonry dam and will cost half or a quarter as much. In fact there is now such a dam in Baltimore, the Druid Lake dam, built in the latter part of the '60's, which is 119 ft. high, of earth, with puddle heart wall, and which has stood the test of service well ever since. The Vyrnwy dam is 161 ft. from foundation to parapet, but only 84 ft. from bottom of valley to overflow. As another sample section of a high earth dam with masonry heart wall we may instance the new Croton dam, which is to be built in this manner for part of its length, and at one point where thus built of earth will have its crest 120 ft. above the ground level.

It is not in the choice of materials, however, that the Vyrnwy dam contrasts most strongly with

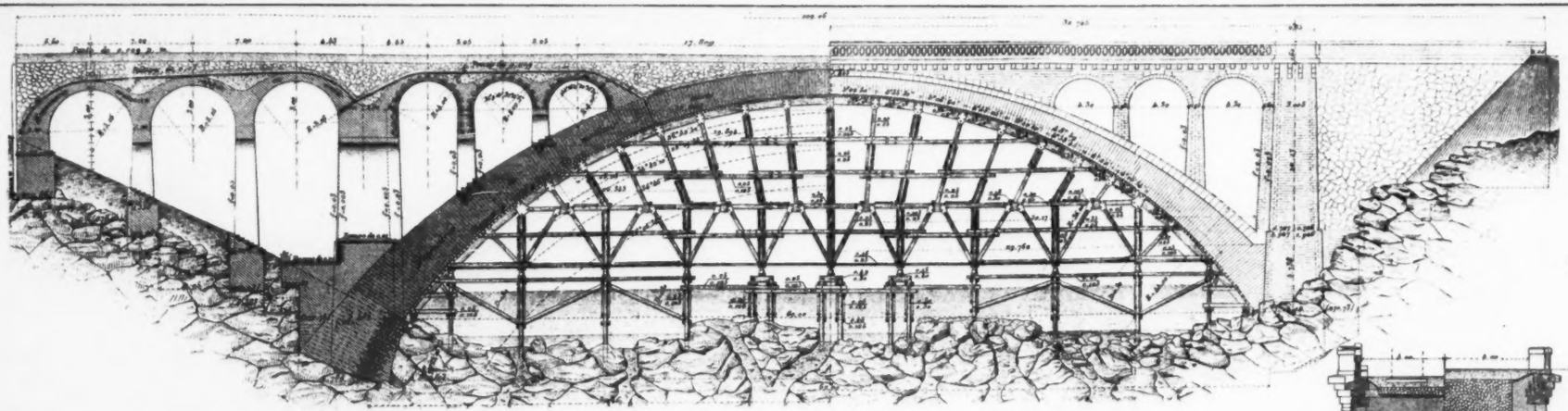
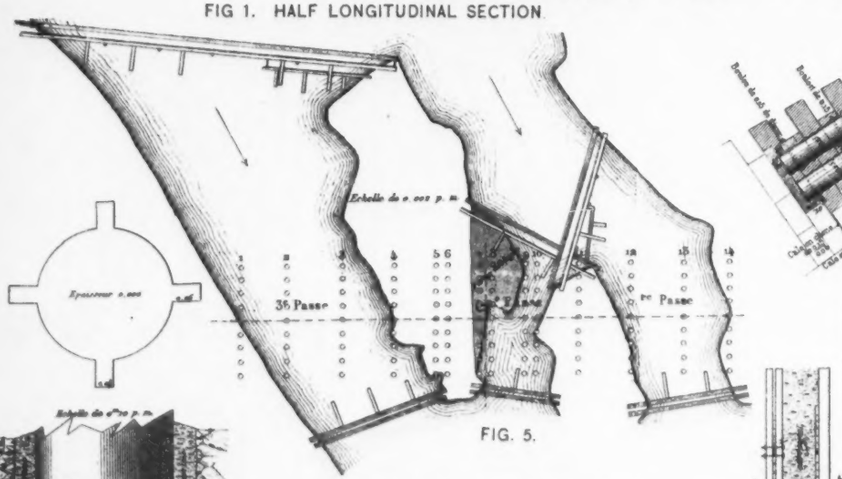


FIG 1. HALF LONGITUDINAL SECTION.

FIG. 2. HALF ELEVATION.



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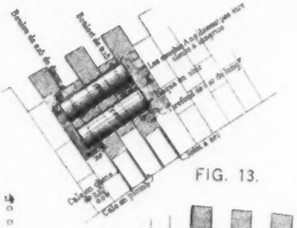


FIG. 13.

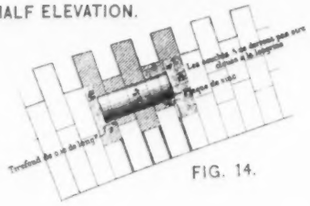


FIG. 14.

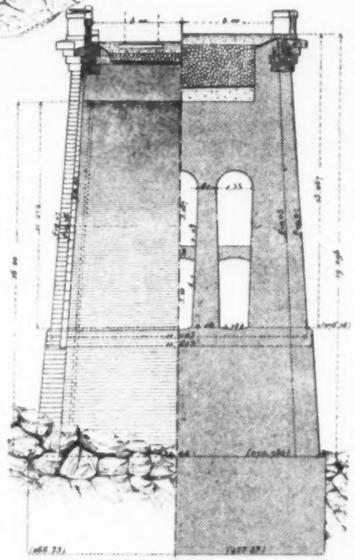


FIG. 3. TRANSVERSE SECTIONS. CENTER. BUTTRESS.

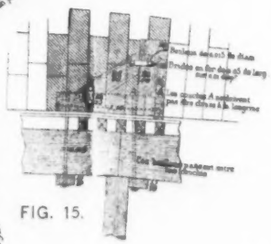


FIG. 15.

FIG. 16.

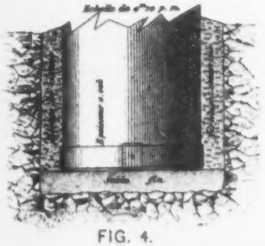


FIG. 4.

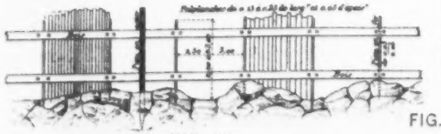


FIG. 10.

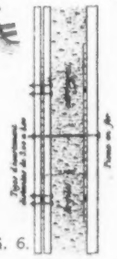


FIG. 6.

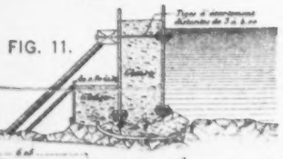
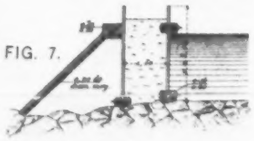


FIG. 11.



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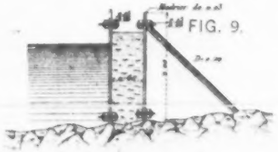


FIG. 9.

FIG. 8.

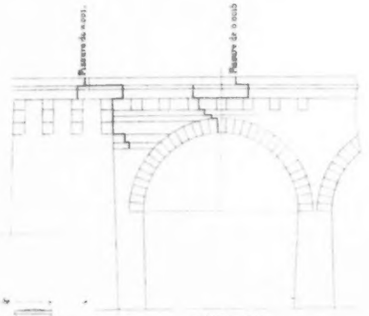


FIG. 23.

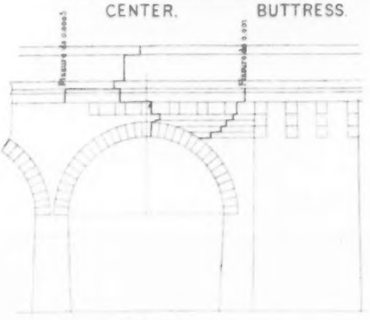


FIG. 24.

FIG. 8.

FIG. 23.

FIG. 24.

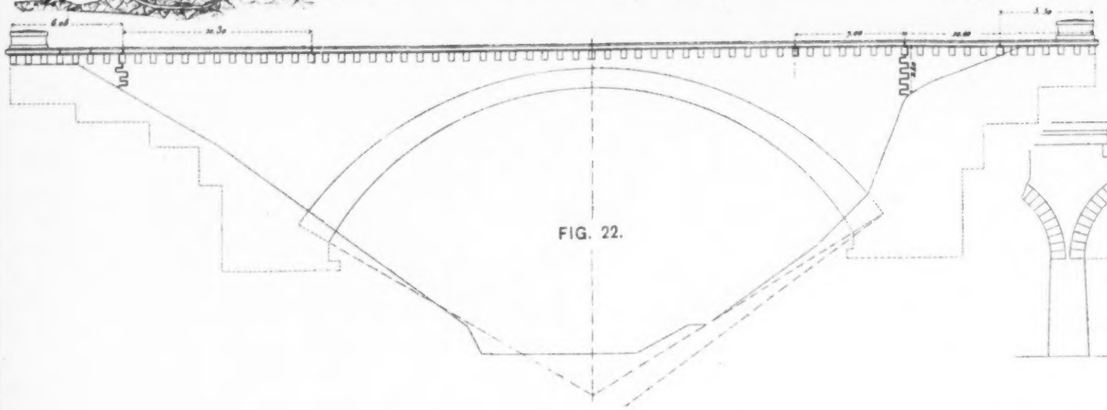


FIG. 22.

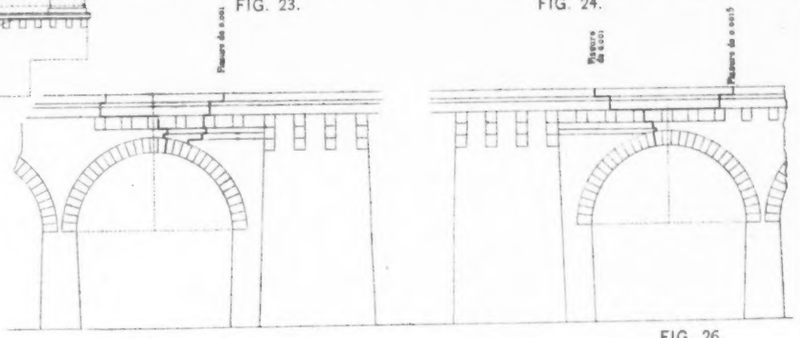


FIG. 25.

FIG. 26.

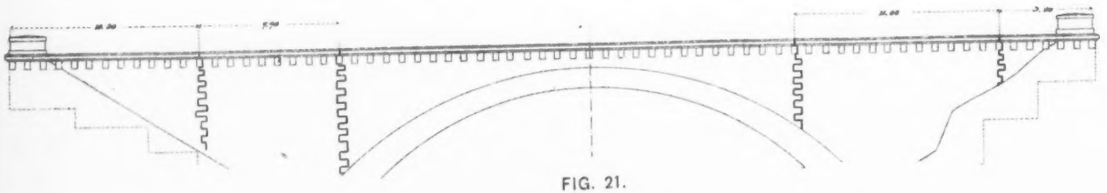


FIG. 21.

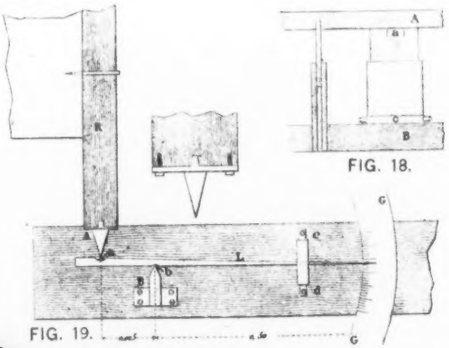


FIG. 19.

FIG. 18.

FIG. 12. DIAGRAM SHOWING
DIVISION OF ARCH INTO "SECTIONS."

ELEVATION.

TRANSVERSE SECTION.

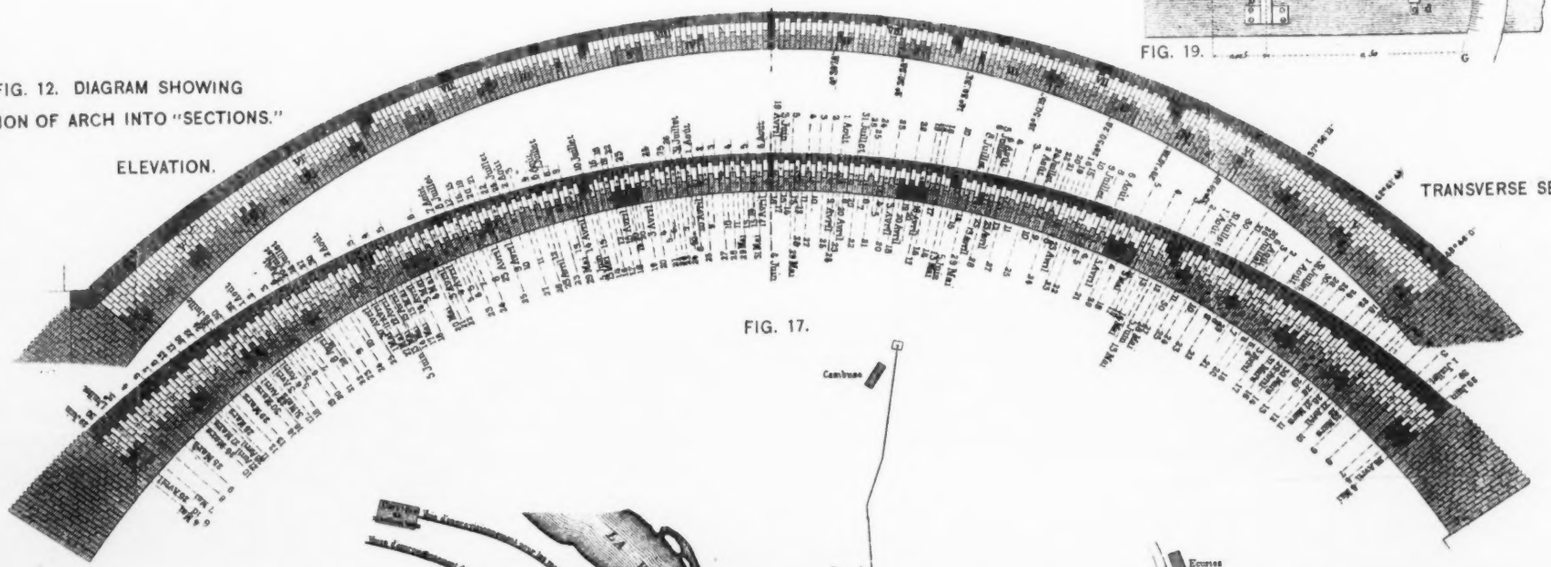


FIG. 17.

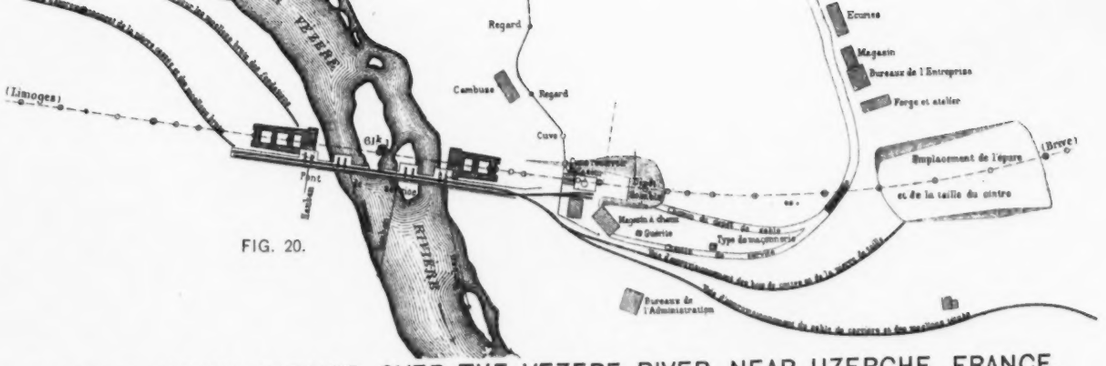
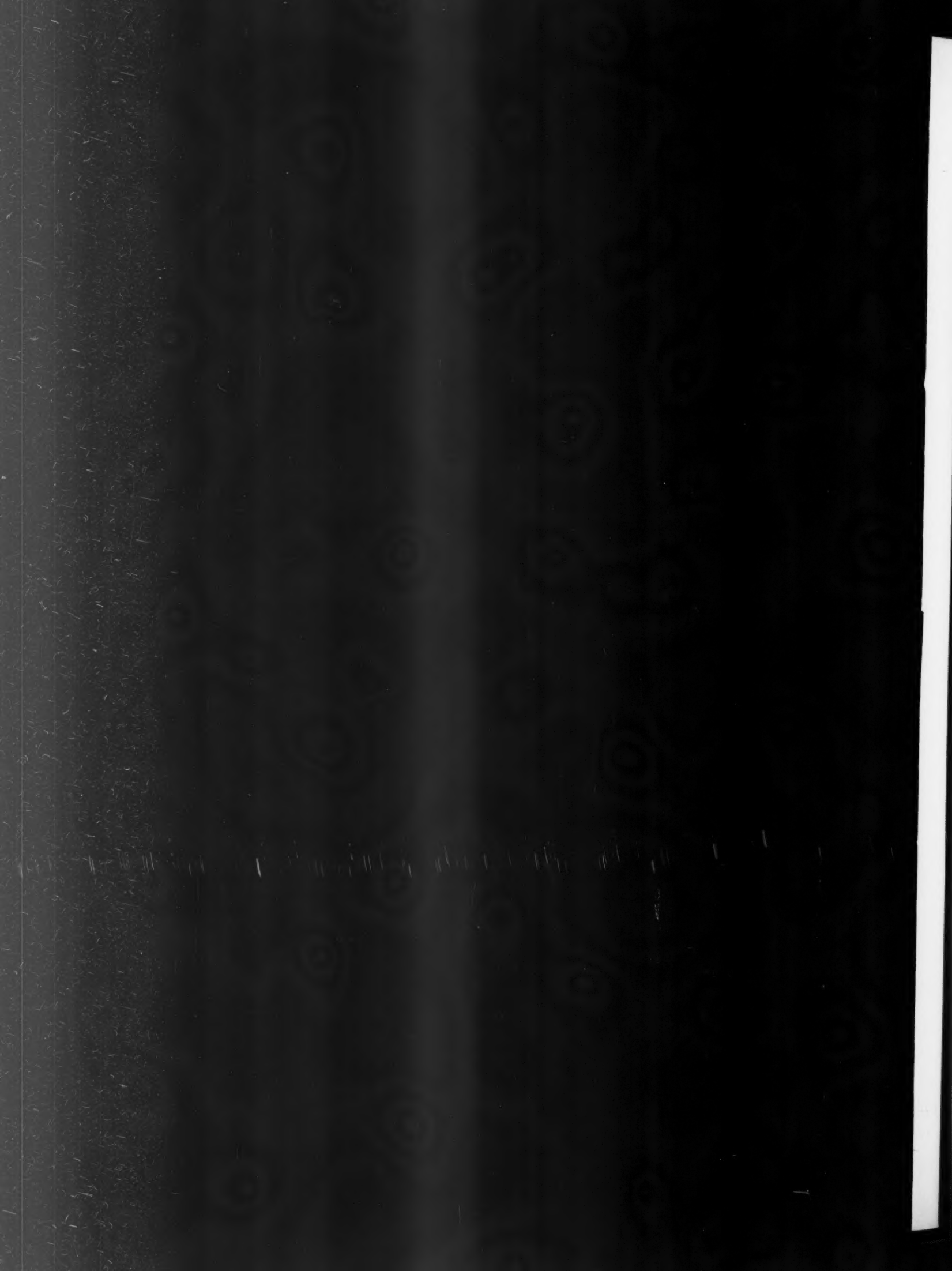


FIG. 20.

THE GOUR NOIR RAILWAY VIADUCT, OVER THE VEZERE RIVER, NEAR UZERCHE, FRANCE.

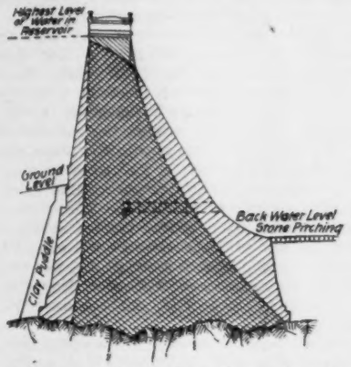
Chief Engineer, M. Daigremont. Assistant Engineer, M. Draux.

CHAS. HART & SONS, LITH., 96 VESEY ST., N. Y.



American practice, but in its great superabundance of strength. In 1888 a report was made on the strength of the Vyrnwy dam by Mr. Russel Aitkin, one of the best authorities among English engineers on masonry dam construction, and after commenting on its enormous margin of strength he said:

I send herewith a cross-section of the Vyrnwy dam, on which I have traced a section of a dam designed by me many years ago for a reservoir in India. The specific gravity of this dam would have been about the same as the Vyrnwy dam. It had an ample margin of



Cross Section of Vyrnwy Dam Compared with Dam Having Usual Factor of Safety.

safety and it was so designed that it might have been raised 5 ft. higher if required; yet you will see that the mass of this dam is largely exceeded by the dam across the Vyrnwy. The Indian dam was to have been built of rubble masonry with Portland cement mortar.

Notwithstanding the fact that the section of the dam was so largely in excess of that actually required for safety, the work was carried out in the most expensive manner. Every stone was bedded on a flat surface and a very rich concrete mortar was used throughout. The result was that this great mass of rubble masonry, measuring 260,000 cu. yds., cost on the average nearly $10 per cu. yd., and this too in England with all its advantages of cheap labor and materials. The greatest compressive strain on any part of the dam is less than 9 tons per sq. ft. The average strength of 11 specimens of masonry taken from the heart of the dam was 293 tons per sq. ft.

Is this superabundance of strength in the Vyrnwy dam to the credit or discredit of its designers? Certainly no engineer trained in the American school of practice, where the duty ever before one is to secure with the least possible expenditure the best results, would think of claiming any credit for spending money to secure additional strength when the demands of safety were fully satisfied. Messrs. Deacon and Hawksley, however, were English engineers, and the latter at least seems to have had his full share of English conservatism. They very naturally followed the British custom of working for a great margin of strength without regard to expense, a practice which is probably more defensible in the design of a masonry dam than in any other structure.

The next point in which the contrast between American and English practice is most marked is in the construction of the inlet tower, or gate house, as we say in this country. This is a massive stone structure 160 ft. high and 47 ft. in diameter at the base. It stands in 50 ft. of water and is connected with the shore by a stone viaduct 140 ft. in length. It is a beautiful tower, graceful and picturesque enough, but an American engineer would stand aghast at the idea of erecting a structure of that size to control a flow of water amounting to only 40,000,000 gallons daily. As an ornament to the landscape the inlet tower is a decided success, and to an American engineer it really appears as if that must have been its chief purpose, for even with the crude and complicated system in use for controlling the flow one can conceive of no reason why a tower half the height and half the size would not have answered every requirement.

In our description in another column we have taken pains to explain at length the system employed for controlling the flow at the inlet tower, in order to draw water from a constant depth about 10 ft. below the surface, whatever the stage of the lake. The system is such a curiosity that American engineers will certainly find it of interest. We will only mention here that it involves the lifting and holding suspended of four vertical columns of 44-in. cast iron pipes by the aid of a hydraulic crane. What happens when the hydraulic crane freezes up or is laid up for repairs we are not informed. If it was really so desirable to take water at a constant depth from the surface, it would not take an American engineer long to design an automatic apparatus, governed by a float, which would do everything that the present system does without attendance and at about a tenth or a twentieth of its first cost. This feature stands upon quite a different basis from the excess of strength in the dam, for which something can be said. It looks rather like absurdly bad engineering for which there was neither temptation nor excuse. A similar criticism must be made on the screens through which the water is strained. These are arranged on huge iron cylinders 25 ft. high and 9 ft. in diameter. When one of these strainers is clogged another hydraulic crane has to be used to hoist it up where it can be washed. The American plan is to place the screen cloth on light rectangular frames, sliding in grooves, which are easily raised by hand when cleaning is necessary.

Of course this matter of the machinery at the inlet tower is a small one, and if a few thousand dollars more than was necessary was spent on it no great harm was done. There is another feature of Vyrnwy works, however, which is far from being of minor importance, since it involved an apparently needless expenditure of over $2,000,000. If it is an example of good engineering practice according to English ideas, then we on this side have new cause to be thankful for the Declaration of Independence and all that has followed it. We refer to the use of what our English contemporaries are pleased to call "balancing reservoirs" on the pipe line. According to American ideas, when the water from the reservoir is once safely started in the pipe line the thing to do is to get it to its destination in the city's distributing reservoirs in the most direct manner possible. In the aqueducts which supply New York City, both new and old, the water flows in an uninterrupted current from the Croton dam to the city's distributing reservoirs, a distance of about 31 miles. The same thing is true of the new water supply for Newark, N. J., through a 48-in. steel pipe line, 21 miles long.

But no such direct course is pursued by the water which supplies Liverpool. Along the line of the Vyrnwy aqueduct there have been built five reservoirs, dividing it into sections averaging about 10 miles in length (with the exception of one section which is 18½ miles). These reservoirs are all small and are not intended for storage. The largest will hold about a day's supply; the smallest would be filled by the aqueduct in ten minutes. The only advantage whatever that we can discern in these reservoirs is that in case of the stoppage of the flow in the pipes they prevent the total head from coming on the pipe, the available head being only that due to the section on which the pipe is located. Of course some provision was necessary to prevent undue pressure on the pipe line at various points, but we fail to see why the provision of relief valves at frequent intervals would not have answered every purpose which is served by these expensive "balancing reservoirs" and at a mere trifle of their cost.

It was of course necessary to locate these reservoirs near the hydraulic grade line. On the lowest section of the line the only available site for a reservoir was on a hill over 100 ft. below the hydraulic grade. Here a mammoth stone tower 115 ft. high, illustrated in another column, was erected, and on top of it was placed a steel tank of 651,000 gallons capacity. The cost of this single structure is given as $657,530, and the cost of the four other balancing reservoirs was $1,706,000, making in round figures a sum of over $2,350,000 expended on these wholly needless structures. The only benefit which is derived from these reservoirs which would not be secured by a proper system of blow-offs and relief valves is a storage amounting all told to about 30 hours flow of the aqueduct, and a beautiful piece of masonry work on Norton Hill.

There are other features in the design of the works which surprise an American engineer, notably the use of cast iron pipes and the laying of three lines of pipe of small diameter, only 39 to 42 ins. American practice would now be to use steel pipe and lay one line of pipe, or at most two, over the whole distance. There are undoubtedly weighty reasons in favor of two lines of pipe rather than one, for a break in one line may leave the other unimpaired, and if the whole supply is not required at once, as is the case in Liverpool, it may pay to defer building the second line until it is needed. But why three lines of pipe should be laid over this long distance is quite incomprehensible on this side of the water. Perhaps it was because the British pipe founders were not up to the art of making any large pipe above 42 ins. diameter, having had no experience in it.

For what part of these peculiar features of this work Mr. Deacon is responsible we are not aware. He has abundantly proved his abilities as an engineer by the work which he did on the Mersey tunnel and by his work years ago in the prevention of water waste, as well as in other directions. For the monumental character of the works carried out under his direction and for their remarkable architectural excellence he is certainly entitled to great honor and credit; but even these praiseworthy features cannot hide the fact that the works as a whole have been planned and carried out in an extravagant and in some cases absurd manner, and that the city of Liverpool ought to have secured its supply from Lake Vyrnwy by works of equal safety, efficiency and beauty for not more than seven instead of over ten millions of dollars.

LETTERS TO THE EDITOR.

A HIGH RATE OF RAINFALL.

Sir: We had in Boston last evening rather a remarkable thunder shower. Aside from the fine electrical display, the rate of the rainfall was very great. The severest part of the storm extended over half an hour and the rate taken from the self-recording gage at Chestnut Hill reservoir was remarkably uniform during that time. The gage showed a precipitation of 1.27 ins. in 30 minutes. The profile line plotted on the paper was almost exactly straight. The whole storm yielded 2.19 ins. Very truly yours,

Desmond Fitz Gerald.

Brookline, Mass., Aug. 12, 1892.

WEB SPLICES.

Sir: My criticism of Mr. C. H. Wright's web splice some weeks ago was upon his statement that, "it is a common practice to make up the section at web-joints by a cover-plate on top of the flange plates," and not as regards the practical value of rivets 4½ ins. long, for transferring the moment of the web through five thick cover plates. I would say, however, that the use of such flanges, especially with such small angles, is also hardly "common practice."

As I have before stated (but which evidently was not comprehended) webs are spliced by plates, called splice-plates, riveted directly to the sides of the web between the flanges. From the communication in last week's "News," I see that Mr. Wright must reside near one of the largest bridge works and where he can, if he wishes, see first class work and verify my statements as regards good practice. Yours truly, C.

THE WASHINGTON & GREAT FALLS ELECTRIC RY.

Sir: On July 29 the President signed the bill incorporating the Washington & Great Falls Electric Ry. The road is to run parallel to the conduit road, along the north bank of the Potomac River for a distance of 16 miles. The trolley system is authorized, and the road is to be built and equipped in the best state of the art. The conduit road is the great driving boulevard of the District of Potomac, the Glen Eco Chautauqua, Woman's National Home, Cabin John bridge, largest single stone span in the world, and the great falls of the Potomac. The road will have double tracks, and the Washington terminal will have elevated tracks for a distance of 3,000 ft. The stock and bonds of the road are to be fixed by the Judge of the Supreme Court of the District of Columbia, not to exceed $1,000,000, and are to be limited to the actual cost of the road and its equipment. The charter is perpetual. Stock books will be opened Aug. 23, at the office of the Washington & Chesapeake Beach Ry. Co., Washington Loan & Trust Co. Building, Washington, D. C., and the company organized for business immediately thereafter.

T. W. Tyler,
Secy. of Incorporators.

Washington, Aug. 10, 1892.

TIE-PLATE AND JOINT FASTENINGS.

Sir: On the subject of a tie-plate under a rail, and an absolute fastening by screw or other bolts, have you ever considered the fact that when we fasten the rail unconditionally to the cross-tie, so that the small amount of allowance which is made by the old spike system and the flexibility of the wood under the rail is entirely eliminated, that the tie and rail will raise

together as the wheel rolls over them, and there will always be the opening or vacant space below the cross-tie? Small as it is now between the rail and the tie, it is a relief which seems to be necessary as the wheel rolls on its way, and it allows, in the present mode of construction, a cross-tie to lay solid on the ballast.

Further, in the wave of the surface of the rail as the wheel rolls over it, there is by reason of the lever power a terrible strain between the rail and the tie, which is very great until the rail is relieved slightly, because the wave has but little height, and when a slight relief or opening comes the intense strain ceases. Whether or not we will damage the rail at the cross-tie junction by these screw bolt fastenings and rigid iron base plates, and whether or not we will have as good track by compelling the tie to rise and leave an opening under the cross-tie, as we now have withe the opening between the rail and the tie, are the questions which I wish to present for consideration of maintenance of way engineers.

Yours truly, Joseph T. Richards,
Asst. Chief Engr., Penn. R. R.

Philadelphia, Pa., Aug. 10, 1889.

(It seems to us that there are two important facts bearing on this question which should be borne in mind in considering it: 1. English track has always had the rail and the tie rigidly connected, and no trouble of the kind which our correspondent seems to anticipate has arisen. 2. We have yet to see the track in fairly good order in which the tie as well as the rail did not rise and fall slightly when a train passed over it. It may be these facts are not decisive, and with some very light rails, especially, we can see how much trouble might arise, but we have never yet heard of any which could be distinctly traced to too rigid connection of rail and tie, though much has arisen from the connection not being rigid enough.—Ed.)

PRECISE LEVELING IN ST. LOUIS.

Sir: In the editions of April 2 and 16 of this year, I noticed articles concerning "A Novel Level" used in correcting the elevations of Switzerland. Perhaps some of your readers will be glad to know something of the accuracy that can be obtained by the use of such a level, when properly handled and under favorable conditions. My only object in sending the following list of bench marks, is to show the constant accuracy of the method. The level was obtained from Fauth & Co., of Washington, D. C. The rods (two) were imported from Kern, of Aarau, Switzerland, and are about 3 meters long and graduated to centimeters. There are three horizontal cross hairs and one vertical one in the eye-piece of the telescope, A "sight" is the mean of the apparent intersections of the three horizontal hairs with the rod. The apparent intersection of each hair is estimated to the nearest half millimeter. This estimation is accomplished more quickly and accurately I find, by placing a black dot in the white rectangular spaces. The dots are 1 centimeter apart lengthwise of the rod and are at the 5 millimeter points. They should be near the center line of the face of the rod. More dots judiciously arranged would increase the accuracy of the estimation. A dot a half millimeter in diameter can be seen 100 meters unless it is a very dark day. This method to some persons may seem to be comparatively inaccurate, but the results obtained are far from it, and the accuracy could be considerably increased by having two more horizontal hairs, without consuming much extra time in taking a sight.

I precede the list with an explanation of it although it is almost self-explanatory.

Column No. 1 contains the number of the bench, each determined (in this case) from the bench preceding. Column No. 2 (omitted) contains the differences of elevation in millimeters and tenths between these same bench marks, as determined by the forward and back run. "N" precedes the difference as determined by running toward the north and "S" toward the south; + or −, preceding these differences, indicates that the new bench is higher or lower than the one already determined. Column No. 3 contains the difference between N and S runs to each bench in millimeters and tenths. Column No. 4 contains the horizontal distance in meters between the successive benches as determined by the zigzag route of the leveler between them. Column No. 6 gives the elevations of the various benches above the St. Louis "City Directrix," as determined by the north runs and the column No. 7, as determined by the south runs. Column No. 8 gives the differences of these results in millimeters and tenths. It will be seen that the two lines are never very far apart.

The total distance developed by the run from No. 398 to No. 432 is 6,705 meters, or about 4 2-10 miles. The shortest sight was 3½ m. and the longest 66 m., the average length of sight being 28 m. The conditions were rather favorable, inasmuch as the line extends through timber from the south end of "Prospect Hill" to the upper end of the city limits of St Louis. Being in timber, I was protected to some extent from the wind and tremulousness of the atmosphere. The leveling was done between the hours of 10:30 a. m. and 4 p. m. of several days. The surface of the ground is very rough, being a succession of ravines and ridges, which accounts for the short sights and the small average length of sight.

Very respectfully, E. J. Jolley,
2d. Asst. Engr. Sewer Dept.

St. Louis, Mo., Aug. 9, 1892.

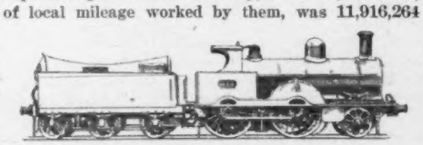
1	3	4	5	6	7
Bench No.	Diff. sits. mm.	Dist. in meters	Elevation (mm. and tenths). by North Run.	by South Run.	Diff. in mm.
399	0.6	165	+12367.2	+12366.6	0.6
400	1.9	735	+9906 !	+9903 6	2.5
401	1.1	210	+35536.4	+35535.0	1.4
402	0.5	110	+38612.0	+38610.1	1.9
403	1.8	265	+39770.1	+39770.1	0.1
404	0.8	155	+36194.1	+36194.8	0.7
405	0.2	250	+22384 7	+22385.6	0.9
406	0.4	90	+31229.6	+31230.1	0.5
407	0.4	80	+23719.5	+23719.6	0.1
408	0.3	335	+2614?.9	+2614?.3	0.4
409	0.5	305	+29312.8	+29313.7	0.9
410	0.4	180	+26875.3	+26875.8	0.5
411	0.7	260	+27358 6	+27358.4	0.2
412	0.3	200	+22749.2	+22749.3	0.1
413	0.1	250	+14115.4	+14115 4	0.0
414	0 3	120	+2695.7	+2.9?6 0	0.3
415	0.2	200	+29419.4	+29419.5	0.1
416	0:2	280	+38057.3	+38057.6	0.3
417	0.3	165	+39230 1	+39230.1	0.0
418	0.9	215	+47367.1	+47368.0	0.9
419	0.4	135	+47831.5	+47832.8	1.3
420	0.2	245	+48811.6	+48812.7	1.1
422	0.3	115	+47895.3	+47896 1	0.8
423	0.0	245	+47?38.7	+47?39.5	0.8
424	0.3	80	+44923.4	+44924.5	1.1
425	0.3	155	+43001.7	+43002.5	0.8
426	0.1	220	+42144.6	+42145 5	0.9
427	0.7	450	+31601.0	+31602 6	1.6
428	0.3	160	+27?06 4	+27408 3	1.9
429	0.5	40	+19916.0	+19917.4	1.4
430	1.0	575	+2694.5	+2694.9	0.4
431	0.4	100	+3265.5	+3265.5	0.0
432	0 4	15	+4931.2	+4930.8	0.4

Note—Column No. 7 furnishes the comparison between the two lines of levels at the various benches. For example, at No. 410 they are 0.5 mm. apart, and at No. 425 they are 0.8 mm. apart, etc.

(Remembering that 1 millimeter=0.00328 ft., and 0.1 mm. = less than one-third of a thousandth, which is the smallest unit used in everyday careful leveling, these results will be seen to be remarkably accurate, and the observant reader will also note how conveniently the metric system lends itself to level work. For all ordinary work the millimeter is the smallest unit which need be employed, and the decimal point is wholly dispensed with. The same advantage obtains in mechanical drafting as is now pretty well known.—Ed.)

MILEAGE OF THE LOCOMOTIVE "CHARLES DICKENS;" LONDON & NORTHWESTERN RY.

In our issue of May 5 we made some comment upon the large yearly and total mileage made by the locomotive "Charles Dickens" on the London & Northwestern Railway. The engine was built at the company's shops at Crewe, to the designs of Mr. F. W. Webb, Locomotive Superintendent, and we are indebted to Mr. Webb for the following official figures of the mileage and for a photograph from which the accompanying sketch was made. The "Charles Dickens" was turned out for its first trip on Feb. 28, 1882, and up to April 30, 1892, it had run 1,071,549 miles, giving an average of 105,398 miles per annum for the ten years. It has been in active service 9 years 218 days of this time, and in the shops 212 days. The average train load of the engine is about ten cars, weighing in the aggregate about 291,200 lbs. The mileage last year of simple express engines on this railway, inclusive, however, of local mileage worked by them, was 11,916,264



The "Charles Dickens"; London & Northwestern Railway.

miles, equal to 32,119 miles per engine. The mileage of Mr. Webb's three-cylinder compound express engines (Eng. News, Jan. 26, 1889) during the same period was 3,095,920 miles, equal to 38,699 miles per engine.

The "Charles Dickens" is a simple engine, with inside cylinders, 17×24 ins.; four coupled driving wheels 6 ft. 6 ins. diameter; and a single pair of leading wheels 3 ft. 6 ins. diameter. The weight on the coupled wheels is about 73,000 lbs., with 50,500 lbs on the driving wheels and 22,500 lbs. on the trailing wheels. The first run was made in February, 1882, as already noted, and by Sept. 7, 1886, the performances had just exceeded 500,000 miles. On round trip No. 2,651, made Sept. 12, 1889, the engine completed the record of 1,000,000 miles in 9 years 219 days, which, so far as we know, is quite unparalleled, as heretofore stated. During that time 92 trips had been made in addition to the regular trips, and the engine had consumed 12,515 gross tons of coal and evaporated 93,237 tons of water.

The regular trip is with an express train from Manchester to London, 183½ miles, and return, making the daily round trip of 367 miles. The engine leaves Manchester with the 8:30 a. m. train, which, according to an 1891 timetable, is due at London at 12:45 p. m., making the run of 183½ miles in 4 hours 15 minutes, with five stops aggregating about 15 minutes. This gives a running time of four hours, or an average running speed of 45.87 miles per hour between stops. The return trip is made with the train leaving London at 4 p. m., making the run to Manchester in the same time. The stops are at Willesden Junction, 5½ miles from the Euston terminal station in London; Rugby, 82¾ miles; Lichfield, 116½ miles, and Stockport, 177½ miles.

In the article above referred to we stated that on the Pennsylvania R. R., in 1885, the highest mileage which any passenger locomotive then had to its credit was 780,182 miles. Several engines had about 500,000 miles to their credit for ten years' service, and one had 41,510 miles for three months, or at the rate of 166,040 miles per year. The average of all passenger engines for that year, however, was 45,936 miles (highest 79,258 miles), which is quite beyond English precedent. Several of the Western roads have been far exceeding Eastern roads in regard to locomotive mileage, and it is possible that some Western road has now a locomotive service which has made a million miles in ten years. From H. M. Minto, Master Mechanic of the New Orleans & Mobile and Mobile & Montgomery divisions of the Louisville & Nashville R. R., we learn that engine No. 69 made a mileage of 113,410 miles, or an average of 9,451 miles per month, during the 12 months January, 1891, to February, 1892, inclusive (July and August are omitted, as the engine went into the shop July 27 with a broken crank pin, and made no record the following month). This is an engine of the eight-wheel type, with cylinders 18×24 ins., driving wheels 5 ft. 2 ins. diameter, and a straight boiler 4 ft. 2 ins. diameter. The monthly mileage ranged from 7,210 to 11,160 miles.

We are indebted to Mr. T. N. Ely, General Superintendent of Motive Power of the Pennsylvania R. R., for the following particulars in regard to mileage performance of locomotives on that road. It must be noted, however, that none of the passenger locomotives are used exclusively for express service, as the system of operating includes the running of short trips with local trains in connection with the other runs. No attempt has ever been made to run a locomotive for a record, as was the case with the "Charles Dickens." It will be seen from the accompanying tables that there were some high mileages made in single years. These occurred, naturally, on account of the shortage of passenger power on some of the divisions. The greatest mileages made by one locomotive with passenger trains on the Pennsylvania R. R. lines have been as follows:

Year.	Mileage.	Year.	Mileage.
1886	103,570	1890	91,680
1887	94,922	1891	92,252
1888	92,483	1891	98,875
1888	100,374	1891	12.,1o2
1889	99,661		

The following table gives the maximum mileage made by each of nine passenger locomotives on the Pennsylvania R. R., from January, 1882, to December, 1891, inclusive, showing an average mileage of 455,102 miles per locomotive for the ten years:

592,453	432,880	501,737
489,362	405,241	402,901
415,846	409,349	446,148

The average mileage of locomotives with passenger trains in the year 1891 was as follows:

Pennsylvania Railroad Division	39,415 miles.
United Railroads of New Jersey Division	35,796 "
Philadelphia & Erie Railroad Division	54,316 "
Average for three divisions, 1891	43,176 "

AMERICAN LOCOMOTIVES IN NEW SOUTH WALES.

In our issue of July 21, 1892, we gave particulars of the performance of the ten-wheel passenger locomotives built by the Baldwin Locomotive Works for the New South Wales Government Railways, together with particulars of the track upon which these engines are run. As we have already stated, there has been considerable discussion as to the efficiency of these engines, especially as some of the truck axles broke soon after the engines had been put in service (Eng. News, July 28), and a government commission was therefore appointed in March to investigate the allegations made that these engines were defective, were unsuitable to the track, and were not rendering the service that was expected of them. This commission has now presented its report, presenting conclusive evidence of the efficiency of these engines, and we give below a very full abstract, referring interested readers at the same time to the articles above referred to, and to the article on English railway practice in the colonies, in our issue of Aug. 4. The report commences by stating the preliminary facts, and the reasons for the purchase of these engines, as follows:

It appears that about the month of August, 1890, and prior to the ordering of the Baldwin locomotives, various negotiations for the supply of engines to be built in the the colony had failed, and English locomotive builders were unable to promptly supply engines sufficient for the then requirements of the railway service of the colony. Under these circumstances, the Railway Commissioners, finding that the exigencies of traffic (especially that anticipated in wool during the then approaching wool season) demanded the immediate supply of further engine power, appointed a committee of responsible officers in the New South Wales railway service, consisting of Mr. D. H. Neale, (Mechanical Engineer), Messrs. Loughry and Stanger (Outdoor Locomotive Superintendents), and Mr. Howe (Workshop Manager), to report upon the merits of the American ten-wheel express passenger and the consolidation freight engines, the information to hand regarding which was that such engines had been tried with most satisfactory results in the United States on railway lines resembling in many respects those of New South Wales. This committee had before it the specifications of an engine which had been supplied by the Baldwin Locomotive Works to the Baltimore & Ohio R. R., and which appeared to the committee to be suitable in every respect for the railways of New South Wales. After careful consideration the committee advised the Railway Commissioners to order from the Baldwin Company engines of a similar character to that described in the specifications, subject to certain modifications in construction, which they considered would render the engines more suitable to the conditions existing in the colony, and these modifications appear to your commissioners, as far as the evidence enables them to judge, to have been judicious. In consequence of the report, 12 passenger engines were ordered and obtained from the Baldwin company, and subsequently 20 engines for freight traffic were ordered and obtained from the same company (including two engines on the compound system, which were ordered by way of experiment, and which need not be considered in this report).

The sufficiency and merits of the passenger and freight engines so obtained are the matters respecting which your commissioners are directed to inquire.

Soon after the locomotives were imported and allowed to run, various defects developed themselves, all of which, it is stated, have been remedied at the expense of the Baldwin company. Of the defects which manifested themselves, it now seems only important to draw attention to the very grave one shown by the undue heating and eventual breaking of certain engine truck and tender axles, which, on being tested, proved to have been made of very inferior iron. On their being informed of the breakages the explanation of the Baldwin company was that the axles had been obtained by them from a manufacturer whose product had been hitherto largely used with good results, and that as the axles was supposed to be made of selected scrap iron no test had been prescribed, as no test of scrap iron axles is conclusive. Subsequent events showed that it was most unfortunate that no test was made by the Baldwin company, as probably it would not then have been left for the above mentioned breakages to lead to the discovery that the material used in these axles was unsuitable for its purpose.

Unquestionably the Railway Commissioners would, if possible, have had an inspection of these engines during their construction, similar to the practice in that respect which is observed in England when engines are there manufactured for the railway service of this colony, and, as a matter of fact, they authorized Mr. Thow, the chief mechanical engineer in the New South Wales railway service, who was about to visit America on his way from England to this colony, to have an inspector appointed if he deemed it desirable; but on reaching America, Mr. Thow appears to have consulted with the most reliable authorities in that country, from whom he ascertained that it was very unusual to appoint an inspector over engines built by such a firm as the Baldwin company; and as it had been left to that company to do its best to supply thoroughly efficient and serviceable engines which would do credit to their builders, and as Mr. Thow was not in a position to give a specification or set of drawings to an inspector, such an officer could not have been of any practical use, especially under a contract which did not provide for the supervision or in any way recognize the authority of an inspector. And it seems that Mr. Thow very properly concluded that the appointment of an inspector would be more likely to relieve the Baldwin company of the responsibility which rested upon them than be of any practical service.

The construction of the locomotives was, therefore, carried through without the employment of an inspector, and after their completion and arrival in this colony they were erected and put into steam under the supervision of an engineer sent for that purpose by the Baldwin company. No test of the material in the engines was at that time applied in this colony. Any test that could have been applied would have involved the destruction of the parts tested, and the Railway Commissioners had not then any reason to doubt the sufficiency of the material in all parts of locomotives supplied by a firm of the standing and reputation of the Baldwin company. It is to be borne in mind that it was only after the Baldwin company had been told of the breakages that the Railway Commissioners were informed by them of the facts relating to the supply of the axles, and that no test of them had been prescribed. As soon as the defectiveness of the axles was established all the engine truck and tender axles were removed steel ones were substituted at the expense of the Baldwin company, and the locomotives were again put into service. Since then three tires of tender wheels have broken, and in some twelve or fifteen cases engine wheels have worked loose on their axles. As such occurrences are unusual on engines which have only given the service which has been obtained from these locomotives your commissioners cannot too strongly approve of the recent determination of the Railway Commissioners to forthwith remove the wheels and axles of all the passenger locomotives with a view of having them properly tested.

Since that decision was arrived at, the tires and axles have been tested under the supervision of Prof. Warren, whose report shows that the steel of which the tires are made is not sufficiently uniform in quality and is too hard and brittle, and thus renders them very liable to fracture. The testing of one of the driving axles under the falling weight showed that its material is defective and unsafe for passenger traffic, but whether the remaining axles may suffice for use in freight traffic, where the slower rate of speed observed renders them less liable to fracture, can only be decided when further tests shall have been made—such as tensile and bending tests on specimens cut from the axle fractured by the process above mentioned.

The track is then described as consisting mostly of steel rails weighing 71½ to 80 lbs. per yd., laid on "ironbark" ties 2 ft. 7 in. to 3 ft. 1 in. between centers, and the article continues:

The evidence of the Chief Commissioner of Railways and of Mr. Rhodes, an engineer representing the Baldwin company, and Mr. Neale, Mechanical Engineer, on the weight of rails and maximum loads on the driving wheels of engines which pass over them shows that heavier engines run upon steel rails which are lighter than the lightest rails in use in New South Wales. For example, in America, the Baltimore & Ohio R. R. uses a 67-lb. steel rail to carry an axle load of 35,168 lbs., and a total weight of engine and tender of 209,000 lbs. The Eastern Railway of France employs engines carrying an axle load of 36,064 lbs. on rails weighing from 69 lbs. to 89¼ lbs. per yd. The rails are 39 ft. long, and are carried on 16 ties per rail.

In America the average of spacing of the ties is 2 ft., but the timber is soft and frequently of inferior quality. The ironbark sleepers used in this colony are superior in hardness and in every other respect to the American sleepers. (The increasing use of metal tie plates add to the efficiency of American track.—Ed.) Sir John Fowler and Sir Benjamin Baker, the most eminent English engineers, are of the opinion that a 70-lb. rail on ironbark ties, laid 3 ft. c. to c., is perfectly safe for axle loads of 35,840 lbs., provided that the ballasting is well maintained and the permanent way in good order. It must be concluded, therefore, that, assuming the material to be good and the conditions last named to exist, the old track of the New South Wales railways is perfectly safe for such axle loads as are carried by the Baldwin locomotives, the weight of which amounts to 34,216 lbs. on the passenger and 34,608 lbs. on the consolidation engines. Inference to the contrary is not to be drawn on account of the breaking of the rail which caused the recent deplorable accident near Tarana, as at the point of fracture an old flaw was discovered which extended from the base upward for about half the depth of the rail, the existence of which was not disclosed till after the accident.

Your commissioners recognize the fact that since their accession to office the Railway Commissioners have done their utmost with the means at their disposal to effect improvement by relaying a large portion of the lines and it is most desirable that provision should be made to enable them to continue their efforts in this direction, which, apart from other considerations, are to be commended on economic grounds. A great deal of evidence was given with the view of showing that the platforms were altered to accommodate the Baldwin engines, but your commissioners think that the proper conclusion to be drawn is that the alterations were made for the purpose of bringing the platforms to the standard gage, and would have been carried out in any event; probably their completion was very properly accelerated in view of the anticipated use of the Baldwin engines. (This is correct, as noted in our issue of March 12.—Ed.) As to the general effect of the Baldwin locomotives on the permanent way, it does not appear that the wear and tear is greater than in the case of other engines; on the contrary, their flexibility renders them less likely to spread the road than the more rigid engines of English manufacture.

The strength of the bridges, in regard to their capacity to carry the Baldwin engines, has been the subject of a special report by Prof. Warren, which states that some of the existing bridges and viaducts are now subject to strains considerably in excess of that which would be regarded as safe according to the best English practice. The Railway Commissioners, therefore, are taking steps to have these structures strengthened, and Mr. Deane, the Engineer-in-Chief for railway construction, has designed stronger types of timber viaducts, in view of the increased weight of the engines now used on the New South Wales railways. The report points out the well known fact that the increase in the weight of locomotives and the strengthening of bridges and viaducts to carry them safely have been very marked during the last ten years in all parts of the world, and that it is not to be supposed that structures intended to carry engines considerably lighter than those now in use should be safe to carry loads greatly in excess of those for which they were originally designed. The report then takes up the question as to whether the engines are rendering the service expected of them.

To ascertain what was really expected of these engines it is necessary to consider the evidence of Mr. Neale and Mr. Stanger rather than the correspondence, because, in consequence presumably of alterations suggested in a letter by the Secretary of the Railway Commissioners, on Sept. 2, 1890, the Baldwin company declined to give a guarantee of speed. An extract from the company's letter to the New South Wales agents, Messrs. Towns & Co., is in these terms: "'We have carefully considered the conditions of service for which these locomotives are intended, viz., to haul 152 to 176 gross tons of cars and load at a speed of 22 miles per hour up long grades of 136 ft. per mile (2.56 %), combined with severe curvature, and to haul up grades of 176 ft. per mile (3.33%), with easier curvature, loads of 120 to 144 gross tons. We note that the sharpest curves are of 528 ft. radius, but it is not stated that this is the radius of the curves in combination with the 136-ft. grade. Our calculations indicate that the engines will have sufficient tractive force to haul these loads, but we prefer not to make a definite guarantee of the speed, as it is more or less dependent upon conditions of which we are not fully informed, such as the quality of the coal, the wheel-base of rolling stock, condition of track, etc."

According to Mr. Neale, the Railway Commissioners had in their letter put the required speed very high, and he states that therefore he was not at all alarmed at the refusal of the Baldwin company to guarantee the speed. In point of fact what was really expected was less than the Baldwin company was asked to guarantee.

The results of trials of these engines (Eng. News, July 21) demonstrate their great hauling power and show that the passenger engines are capable under favorable conditions of hauling trains weighing 152 tons up a long grade of 1 in 40 (2½%), at a speed of 19½ miles an hour after the engines have settled down to their work. The reports also show that an average speed of about 21 miles an hour with such a load could be obtained over the whole length of the grade above referred to. It is to be remembered that the chief purpose for which the Baldwin engines were imported was to draw heavy loads over lines of railway most

exceptional in their character on which steep grades and sharp curves are of frequent occurrence, especially on the Western line, which is stated to be more difficult to work than any of the Alpine railways.

The conclusion of the report is, on the whole, extremely favorable to the American locomotives, but it will be noticed that, owing probably to the unfortunate failure of the axles, the commission is disinclined to trust the new steel axles, and advises that they should be tested, and also recommends that an inspector be appointed to supervise the construction of other foreign built engines, as has hitherto been the custom with English-built engines for the colony. It seem to us more than probable that all this tempest in a teapot over a few locomotives has been shrewdly fomented in the interest of English locomotive builders, and that much of the excitement has been manufactured in order to create an impression that where there is so much smoke there must be some fire. But it still remains true that in fighting for a new market where national prejudice and rival trade interests may play such an important part, locomotive builders and all manufactures of machinery, etc., for export, cannot be too careful in their material and workmanship, to keep up their reputation and command the confidence of their customers. The conclusion of the report reads as follows:

In conclusion your Commission has the honor to report that in its opinion the Baldwin engines are not unsuitable to the permanent way of the colony; they are not defective in design, and when the objectionable tires and axles have been replaced by others of approved quality there is no reason to doubt that they will be capable of rendering the service which was expected of them.

As the Baldwin works were, considering their reputation, very naturally relied upon to furnish engines of high-class material, and as, so far, much disappointment and many failures have resulted from that reliance, your Commission thinks it would be prudent that the driving axles of the consolidation engines should be sufficiently tested to prove their suitability or otherwise for goods traffic; that the Otis steel axles supplied by the Baldwin company to replace the iron axles of the engine trucks and tenders should also be tested, and that the system of inspection which is carried out in the case of engines constructed for this colony in England should be adopted in all cases.

IMPROVEMENT OF THE NEW YORK STATE CANALS.

The question of the improvement of the canals of the State of New York is one of great importance to the commerce of New York city, and, as noted in our issue of Aug. 4, the Canal Improvement Union is arranging for a convention to consider the further improvement of the canals, and to perfect plans and a system of organization for carrying such improvements into effect. Hon. George Clinton, of Buffalo, is President, and Mr. F. S. Gardner, of New York, is Secretary of this association. In our issue of May 5 we gave some notes from the report which was presented to the legislature in April, by Mr. John Bogart, ex-State Engineer. According to that report the improvements now in progress on the Erie Canal will give a uniform depth of 7 ft. of water throughout, and it is also intended to double the length of the locks, as the bulk of the important traffic is carried in "double-header" boats, consisting of two boats connected together,, a method which secures a large economy in transportation. There is also a steady increase in the use of steam canal boats, which are propelled by screws, and generally push one consort in front and tow two others behind. The increase in the length of the locks will greatly facilitate the traffic, both by double-header boats, and steamboats with consorts. The present canal boats have a capacity of about 250 tons. The freight on wheat from Buffalo to New York in 1891 averaged 3½ cts. per bushel, at which rate there was little profit, and an actual loss if less than seven trips were made. Mr. Bogart stated that if the policy of maintaining the efficiency of the Erie Canal is to be continued, the full depth of water must be secured, the locks lengthened and the canal maintained in proper condition, in order to facilitate and encourage traffic. In connection with the often-suggested water route from the great lakes to the head of navigation on the Hudson River, the suggestion has been made to rebuild the Erie Canal, and make it available for vessels drawing 18 ft. of water. This subject was discussed editorially in our issue of May 5, and the conclusion presented that the growth of traffic between the Mississippi Valley and the seaboard demands careful study of the possibility of a ship canal to accommodate it, and that such a canal, if not too costly, would pay, even though the traffic by railway, which the canal would displace, be estimated at its minimum rate.

From a pamphlet issued by the Canal Improvement Union, New York, we take the following particulars in regard to the traffic: In 1817 the act was passed under which the Erie Canal was constructed, and the canal was finished in 1825. The Erie, Oswego and Champlain canals connect the Hudson River with the St. Lawrence and the great lakes, and the traffic over them has been steadily increasing. The Union proposes to hold a convention before the approaching election, for the purpose of considering the improvements, and the means of carrying them into effect, as already noted, and all manufacturing and commercial organizations, city boards and officials, and all persons who are in favor of such improvements, and of the holding of the convention, are requested to communicate with the Secretary, Mr. F. S. Gardner, 55 Liberty St., New York.

Starting with the navigation season of 1837, twelve years after the canals were opened, and taking 20 years to and including 1856, the total tonnage of the canals for that period of 20 years was 50,326,487 tons, with an estimated value of $2,586,465,277. During the 20 years ending with the season of 1891, the total tonnage of the canals was 106,844,759 tons, with an estimated value of $3,315,599,201. In the earlier period of 20 years the tonnage was less than half the tonnage of the later 20 years; just 56,518,272 tons less. The tonnage of the first 20 years mentioned was smaller than the tonnage of the 10 years ending with 1891, by 1,516,942 tons.

During the season of 1891 the canals brought to New York one-third of all the grain delivered at this port, and notwithstanding the severe competition of the railways and the low rates prevailing on them, the canal deliveries were increased over the preceding year by 1,511,294 bushels.

The total receipts of grain at New York during the seven months of navigation for the eight years, 1884 to 1891, inclusive, were as follows:

By canal	286,456,942	bushels.
By rail (all routes)	295,944,722	"
River and coastwise	5,845,647	"
Total	588,247,311	"

The canals alone, therefore, brought to New York 14,666,573 bushels of grain more than all the railways and other routes combined, during the above period.

The superintendent of public works in his last report said that with the single exception of lock lengthening and the ordinary repairs, no improvements or extensions have been made to the canals since 1856, and that it is well to consider the improvements that have been made in railway operation since 1856, with the increase in power of engines, capacity of cars, and length of trains, in order to facilitate the handling of the traffic.

When the Erie Canal opened in May, 1891, the rail rates on grain from Buffalo to New York were 7 4-5 cts. per bushel, while the canal rates were from 2⅝ to 3 cts. per bushel. Rail rates fell at once to meet canal rates. Of this the Superintendent of Public Works said in his report: "Never before has such a violent and persistent war of rates existed between trunk lines combined on the one side and the Erie Canal on the other. This competition was commenced upon the opening of the canal this year, and was continued during the entire season until its close." The day after the canals were closed rail rates were advanced more than double, and, in some instances, contracts made by the railways when the canals were open were repudiated when they were closed. The Superintendent of Public Works said further:

The difference between the pool rates and the actual rates which have been charged by the railways, which is about 3¾ cts. per bushel, is the amount which has been saved to the consumer by the canal, without regard to the amount carried by the canal. The saving has been made upon every bushel of western grain that went to the port of New York during the season of canal navigation, whether it went by rail or by water. As the amount of grain received at the port of New York by all the various transportation routes from May 1 to Dec. 1, the time during which the canal was open, was 110,812,180 bushels, here is a saving of over $4,000,000 on the necessaries of life alone. This sum was saved to the consumer by the canal, and would otherwise have gone to the railways, and in this single service has the canal maintained its usefulness.

The following is an abstract from a letter by the President of the New York Board of Trade and Transportation:

The nearer the rail rate comes to the canal rate, just in that proportion will the advantage that the canals give our state over competing routes become less, and our hold weaken upon the commerce which has made us great and rich. That is to say: If the canals are permitted to go into decay; if by neglecting to improve the canals, while the railways adopt every improvement, the time shall ever come when our canals have practically no advantage in cheapness of transportation as compared with railways, then will New York have lost her supremacy. The railways of this state, great as they are, cannot alone hold, unaided by the canal, and do not now hold the trade when the canal is closed, as against the railways running to the competing ports of Philadelphia, Baltimore and Boston. The statistics of recent years show that when navigation is closed (about five months in the year, New York railways are powerless against rival routes, and also that when the canal is open and directing the current of trade toward New York harbor we easily outstrip competitors.

From the statistics referred to we have compiled the following table, showing the effect of the canals upon the grain trade of the port of New York:

		—Receipts of grain at—	
		New York, bushels.	Phila., Balt. and Bost., bushels.
1887, canal nav.	open	74,563,500	33,118,979
1887, " "	closed	22,945,633	25,688,918
1889, " "	open	61,165,204	39,944,794
1889, " "	closed	24,348,329	22,160,026

The pamphlet referred to concludes as follows:

The determined competition of the railways with the boatmen presents one of the most serious dangers to the permanence of the canals. If the railways succeed, although with great loss to themselves, in carrying freight for a few years so low as to deprive the boatmen of a profit, exhaust their small capital and drive them to other pursuits, the canal will be as surely abandoned as if it were drained of its water and filled with earth. The canals of the present day are antiquated. As has already been stated, no improvement to them has been made in 30 years, until the movement started in 1885 resulted in the lengthening of some of the locks. The objects of the Canal Improvement Union are to secure the completion of the enlargement of the locks and the further improvements of these canals by the state, through acts of the legislature, so that their efficiency and supremacy, as the cheapest possible route of transportation, may be maintained; so that the business may be profitable to the boatmen; and, through the advantages which such route will give to New York city and state, we may preserve and maintain our preeminence in population, commerce, manufacture and wealth. It is clear that if the freights delivered by our canals to the port of New York during the canal season were subtracted from the total deliveries at this port this great volume of business which supports the prosperity of our city and state would be greatly reduced. It is also clear that but for the influence of the canals in keeping freight rates down to a reasonable limit the cost of transportation on all classes of freight by railway would be much advanced, so as to send to other ports nearer by railway to the West than New York, and through such other ports to the outside world, the large majority of the freights and business now done through our city and state as the highway of commerce. The disastrous effect upon every interest in New York of such diversion of business cannot be estimated. During the sessions of the legislatures of 1885, 1886, 1887, 1888 and 1889, appropriations were made to begin and carry forward the needed improvements to our state canals. Since the season of 1889 hostile influences have prevailed at Albany. In 1890, the Improvement bill failed in the assembly after passing the senate. In 1891 the bill after passing both senate and assembly was vetoed by the Governor. Thus for two years has the improvement of our canals been abandoned and the policy of the previous five years reversed.

Electric lights have been introduced into the town of Hammerfest, Scandinavia, the northernmost town in Europe, according to the "Gesundheits-Ingenieur." The necessity for this improvement will be realized when it is remembered that from Nov. 18 to June 23, a period of 66 days, no sun is visible, so that during that time the plant has to be kept working without interruption. In the summer, however, the conditions are reversed, as the sun does not set for 71 days. The dynamos are located about one mile north of the town, where the necessary power is obtained from the falls of three small rivers emptying into the Arctic Ocean.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XVIII.

THE COLLEGES OF CIVIL ENGINEERING.

The accompanying Table XVII. shows the number of graduates in civil engineering only from the 52 schools which we have previously listed in Table XIV. (issue of Aug. 4, 1892). There are several other schools which we might have listed in the table, as explained in subjoined notes, but as we did not include them in that table, we do not include them in this one, nor in the table next following for mechanical engineers, which are deduced from the same records.

We also show graphically on the accompanying diagram (1) the total number of graduates shown in Table XVII. (which may be 90 to 95% of the total number of graduates in civil engineering from all the schools in the country), and (2) the number of graduates in from each of the six largest engineering schools (measured by 1892 graduates), and from the Lawrence Scientific School, which is prominent by reason of its connection with Harvard. We could have wished to show two or three other schools of high rank on this diagram except that it is crowded as it is.

Looked at superficially, apart from the records of mechanical graduates, there is little evidence in this diagram and table of any decrease in the number of "civil" graduates, either relative or absolute. The total number of graduates listed by half decades since 1860 are:

	No. C. E. graduates.	Miles Ry. built.
1860-64, 5 years	153	5,119
1865-69, 5 "	289	12,936
1870-74, 5 "	657	25,541
1875-79, 5 "	1,048	14,199
1880-84, 5 "	902	38,975
1885-89, 5 "	1,202	35,974
1890-92, 3 "	1,014	11,948*
Total	5,355	144,812

It will be seen that the number of graduates in the last three years has been almost as large as in any five years heretofore, and the number graduated this year (371) was considerably larger than ever before. But when we consider the enormous expansion in railways, water works and other kinds of public works since 1870 (see the last column above and our colored diagram published April 27, 1889) the number of recent graduates is disproportionate even to the increase in railway construction alone, not to speak of railway maintenance. Evidently the future is being discounted somewhat. The proportionate amount of engineering skill to be absorbed by the mere construction of new public works is expected to be considerably less in the future than it has been in the past; though the absolute amount will continue to increase and with it the number of graduates to do it.

That most of our engineering schools are still in their infancy, and are to double and triple their number of yearly graduates, seems to be indicated by the large proportion of schools which are still graduating very small classes. Some of these may always continue to do so, but in the main it must be that the schools have been founded with the expectation of much larger classes than they have now. Otherwise it would hardly pay to found them. By running over the records of the colleges which are now most successful, much support for this hope will be found. In most cases they had a long period of very small classes to live through before they reached their present large classes.

It is notable that a large proportion of the total number of graduates come from a few of the larger colleges, though this tendency is still more marked with the mechanical colleges. Taking 1892 only, of the 44 colleges of civil engineering in the table:

1 (Rens. Polyt. Inst.) had							33	grads. 33
1 (Cornell Univ., C. E. Dept.) had							32	" 32
2 (Mass. Inst., Tech. and Yale) had							25	" 50
1 (Columbia) had							18	" 18
1 (Lehigh) had							17	" 17
Totals of 6 schools (averaging 25 each)								150
2 had	12	grads.	24	3	had	7	grads.	21
2 "	11	"	22	2	"	6	"	12
4 "	10	"	40	5	"	5	"	25
2 "	9	"	18	4	"	4	"	16
2 "	8	"	16	4	"	3	"	12
				7	"	2	"	14
11	"(av.11	each)	120	1	"	1	"	1
(T'l No., 1892, grads.371)				26	"(av.4	each)		101

To summarize, six schools out of 44 turn out 40½% of the graduates, and 11 schools (or just one-fourth of all) graduate one-half; while 17 schools graduate no less than 73% of the whole, leaving only 27% to the remaining 26 schools. Nevertheless, among the remaining 26 schools which had seven or less graduates in 1892 there are two or three at least which already stand in the front rank of civil engineering schools, and a much larger number which bid fair to do so. It is to be remembered also that this list shows the rank of the schools in respect to civil engineering graduates only.

It is not without significance, however, that almost the only two schools in the entire list which are schools of civil engineering and nothing else stand at the very top of the list in respect to numbers, viz., the Rensselaer Polytechnic Institute and the Civil Engineering College of Cornell. It will be remembered that the Cornell engineering schools, though attached to the same university, have an absolutely independent organization, being under separate directors and having a separate staff of professors. The rapid rise of the mechanical engineering school we have already sketched. But from the facts which have been given it will be seen that the progress of the civil engineering college, though less rapid absolutely, is about equally great relatively to its field and to the existing demand. More cannot well be asked of any school, even with such relative ample means as Cornell, than that it shall keep equal with the best of its rivals, and Cornell has done this in respect to numbers at least, as the accompanying diagram shows.

Every engineer must feel genuine pleasure, however, in seeing that Rensselaer, the great original of all our engineering schools, still maintains its lead in its own chosen field. Considering that it has always been somewhat pinched for means, it has certainly made good use of all the talents that were intrusted to it.

The four next largest schools have large classes in mechanical and mining engineering also, it is to be remembered. The instruction given at these six larger schools, as also the requirements for admission, are as advanced as are any in the list, and much more advanced than most, as we shall see later.

Table XVIII. gives the same facts for the mechanical engineering schools as Table XVII. does for the "civils." We make no attempt to construct any diagrams for the mechanical schools separately, however, for the simple reason that their development has been too recent and too rapid to have a diagram show anything more than a table. So far, the tendency of instruction in mechanical engineering to concentrate itself upon a few schools is much more marked than with the "civils," making a summary of 1892 graduates similar to that given above for the latter:

The indications are that the demand for instruction in mechanical engineering has arisen so rapidly that suitable arrangements for furnishing it of satisfactory quality could not be made at many schools, which has perforce driven aspirants for it to the few schools which were well equipped. Hence if any falling off in the relative importance of these latter schools should be observed hereafter it is not to be set down to their discredit. Good instruction in mechanical engineering requires a far more expensive plant than almost any other kind of instruction, and such a plant (not to speak of the staff to use it) cannot be improvised at once. Perhaps this fact will always tend to cause larger classes at a smaller

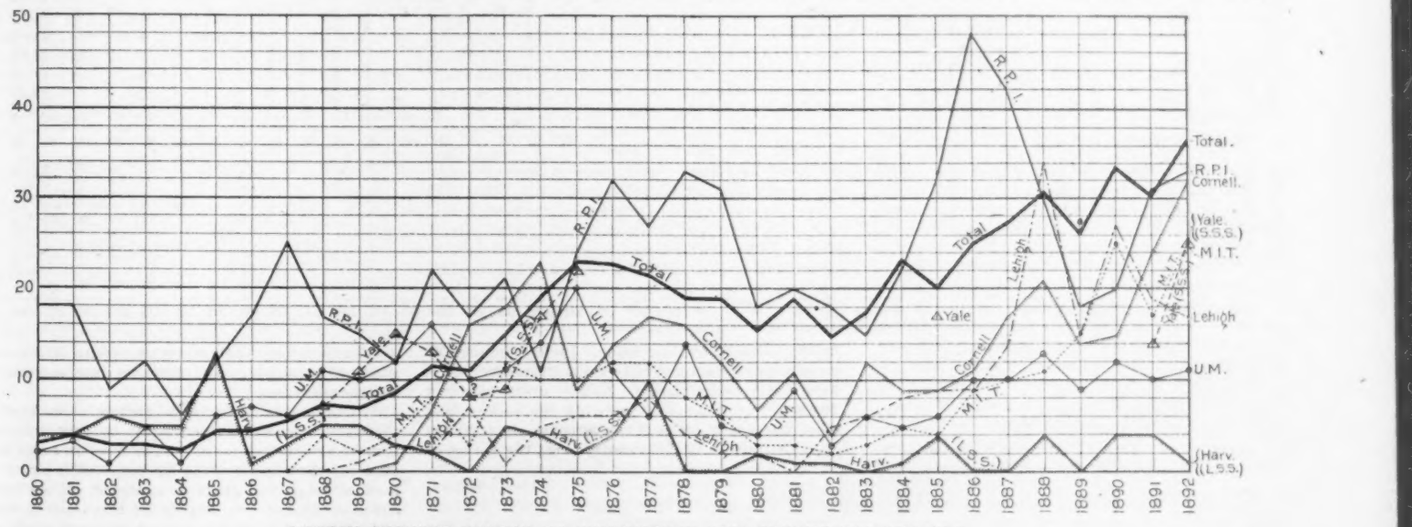


DIAGRAM SHOWING NUMBER OF GRADUATES IN CIVIL ENGINEERING SCHOOLS.

(The total number of graduates in civil engineering from all the colleges listed is shown by a heavy black line to one-tenth scale. The line for Yale is incomplete, for lack of accurate reports.)

1 school	(Sibley Coll. Cornell) had	79	graduates.
1 "	(Mass. Inst. Tech.) had	61	"
1 "	(Yale; Sheffield S. S.) had	40	"
1 "	(Stevens Inst. Tech) had	39	"
1 "	(Rose Polt. Inst.) had	23	"
1 "	(Worc. Polyt. Inst.) had	22	"
Total of 6 schools (aver. 45½ each)		273	"

(Against only 150 graduates from the 6 largest C. E. schools.)

2 had 20	graduates each 40
1 had 19	graduates 19
1 had 17	graduates 17
Total of 10 largest schools	349

(No other than these 10 schools had so many as 10 graduates.)

1 had 9	graduates 9
4 had 8	graduates 32
2 had 7	graduates 14
2 had 6	graduates 12
1 had 5	graduates 5
2 had 4	graduates 8
1 had 3	graduates 3
5 had 2	graduates 10
3 had 1	graduate 3
1 had 0	graduate 0
22 had (av. 4	each) 90

* Estimating 1892 at 3,700 miles.

number of schools, which will not be just cause for regret. The total number of colleges which now have courses in mechanical engineering is considerably larger than above; at least 50 in all, which are aiming toward first-class instruction.

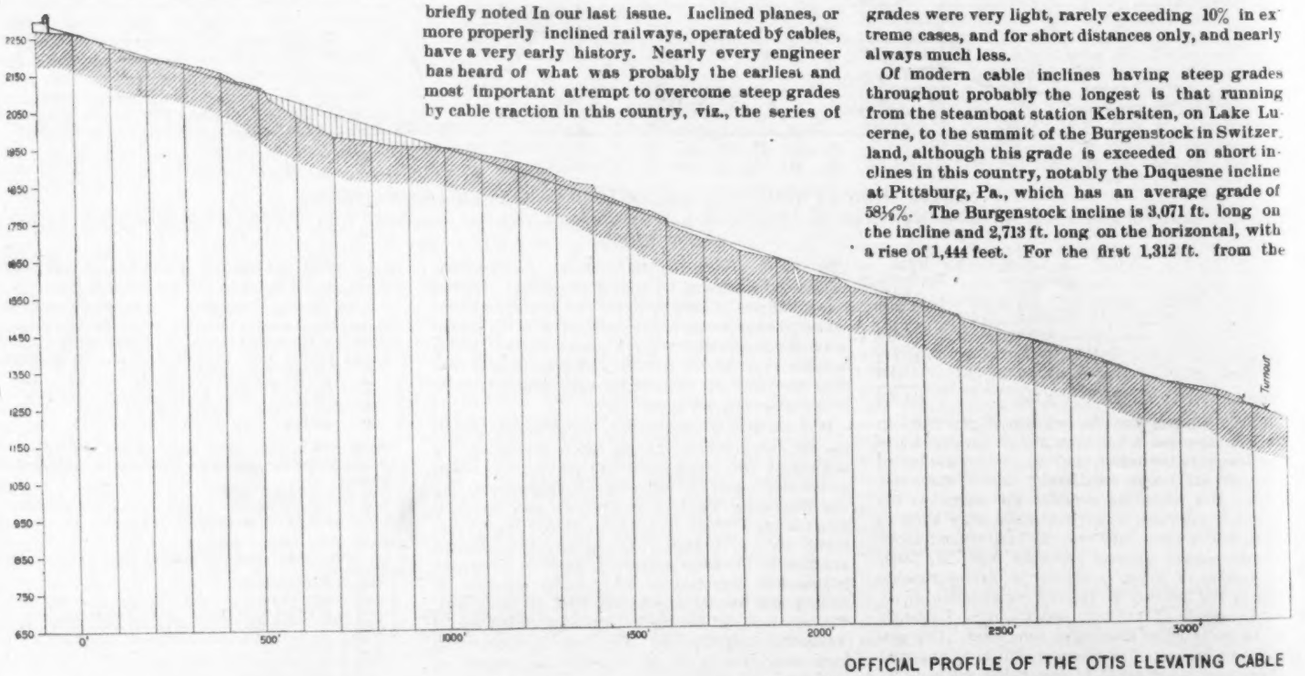
THE OTIS ELEVATING CABLE RAILWAY.

The longest cable incline railway in this country, and with but few exceptions the longest in the world, has just been opened for traffic up the eastern slope of the Catskill Mts. in New York, as briefly noted In our last issue. Inclined planes, or more properly inclined railways, operated by cables, have a very early history. Nearly every engineer has heard of what was probably the earliest and most important attempt to overcome steep grades by cable traction in this country, viz., the series of planes on the first Portage Ry., between Hallidaysburg, Pa., on the eastern base, and Johnstown, Pa., on the western base of the Allegheny Mts., on the line of the Old Pennsylvania Canal. Similar but much shorter planes were also formerly used, and are still to some extent, to transfer canal boats on the old Morris & Essex Canal. In England inclined lifts for canal boats were used at even an earlier date, being mentioned as early as 1774. Compared with the cable inclines of the present day, however, their grades were very light, rarely exceeding 10% in extreme cases, and for short distances only, and nearly always much less.

Of modern cable inclines having steep grades throughout probably the longest is that running from the steamboat station Kehrsiten, on Lake Lucerne, to the summit of the Burgenstock in Switzerland, although this grade is exceeded on short inclines in this country, notably the Duquesne incline at Pittsburg, Pa., which has an average grade of 58⅛%. The Burgenstock incline is 3,071 ft. long on the incline and 2,713 ft. long on the horizontal, with a rise of 1,444 feet. For the first 1,312 ft. from the bottom the grade is 32% and for the remainder of the line 57%, giving an average grade of 53% throughout. This line is also notable as being one of the only two inclines of any length, so far as we know, which use electric power generated by dynamos actuated

TABLE XVII.—TOTAL NUMBER OF GRADUATES FROM COURSES OF CIVIL ENGINEERING FOR ALL OF THE FIFTY-TWO COLLEGES LISTED IN TABLES XIII. XIV., HAVING GRADUATES FROM SUCH COURSES, FOR EACH YEAR SINCE THEIR FORMATION.

	1860	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892
1. Rensselaer	18	18	9	12	6	1	17	25	17	15	12	22	17	21	11	24	32	27	33	31	18	20	18	15	22	32	48	42	30	18	20	31	33
2. Harvard	4	4	6	5	5	13	1	3	5	5	3	2		5	4	2	4	10	..	..	2	1	1	..	1	4	..	..	4	..	4	4	1
3. Yale	(2)	(2)	(3)	(4)	(3)	(6)	(5)	( )	(7)	(11)	(15)	(13)	(8)	(9)	(17)	(22)	(18)	(15)	(14)	(13)	(19)	(18)	(17)	(19)	(22)	(17)	(17)	(16)	(18)	(16)	(14)	(14)	(25)
4. Dartmouth	....	3	4	2	1	4	2	4	6	4	7	6	2	9	13	6	5	7	5	10	6	9	3	8	7	11	6	9	10	5	11	5	8
5. Union	6	9	6	2	7	4	9	12	9	8	6	6	4	5	13	14	12	13	2	3	7	4	7	6	11	9	8	6	4	4	5	5	10
6. Univ. Mich.	2	3	1	5	1	6	7	6	11	10	12	16	10	11	14	20	11	6	14	5	4	9	3	6	5	6	16	10	13	9	12	10	11
Totals, Group A	32	39	29	30	23	45	41	50	55	53	55	65	41	60	72	88	82	78	68	62	56	61	49	54	68	79	89	83	79	52	66	69	88
7. Brooklyn Polyt. Inst.	....	....	....	....	....	....	4	4	5	4	4	7	2	3	6	9	8	10	4	6	3	8	5	4	7	2	7	7	8	7	7	(5)	5
8. Penna. Mil. Acad	....	....	....	....	....	....	....	3	5	3	8	7	12	9	3	18	8	10	8	15	13	19	9	7	14	13	10	14	11	11	16	8	5
9. Columbia	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	5	5	5	6	7	8	4	6	11	4	9	11	12	17	17	13	18
10. Wash. & Lee	....	....	....	....	....	....	....	....	2	2	1	2	3	8	4	7	2	2	2	....	1	....	2	....	....	....	2	2	2	1	....	....	4
11. Mass. Inst. Tech.	....	....	....	....	....	....	....	....	6	2	4	8	3	12	10	10	12	12	8	6	3	3	2	3	5	4	9	10	11	15	25	17	25
12. Lehigh	....	....	....	....	....	....	....	....	....	1	3	2	7	1	5	6	6	8	4	2	2	....	5	6	8	9	9	14	34	15	27	19	17
13. Univ. of Va.	....	....	....	....	....	....	....	....	....	4	....	2	2	3	3	2	2	3	....	....	....	1	3	1	1	....	3	....	2	5	3	2	4
14. Cornell Univ. (C. E.)	....	....	....	....	....	....	....	....	....	....	1	7	16	18	23	9	14	17	16	12	7	11	4	12	9	9	11	17	21	14	15	24	32
Totals, Group B	....	....	....	....	....	....	4	7	18	16	21	35	45	54	54	64	57	67	47	47	36	50	34	39	55	41	60	75	101	85	110	88	110
15. Tufts	....	....	....	....	....	....	....	....	....	....	2	1	....	4	2	2	3	1	4	5	3	3	....	3	1	2	2	4	7	1	2	2	4
16. Univ. of Ga.	....	....	....	....	....	....	....	....	....	....	2	5	5	3	5	1	5	3	2	1	2	1	3	6	3	2	6	2	5	4	5	3	3
17. Lafayette	....	....	....	....	....	....	....	....	....	....	2	2	2	6	9	6	11	12	3	3	4	2	2	6	9	7	5	5	6	4	9	(6)	6
18. Washington	....	....	....	....	....	....	....	....	....	....	2	3	2	3	5	4	....	3	3	2	....	3	1	....	4	2	1	6	3	1	1	1	2
19. Univ. of Vt.	....	....	....	....	....	....	....	....	....	....	2	2	2	4	3	3	1	3	1	1	2	1	4	1	2	5	8	5	4	3	5	6	4
21. Worc. Polyt. Inst.	....	....	....	....	....	....	....	....	....	....	....	4	8	6	7	7	13	8	4	8	2	4	7	4	6	7	9	4	7	4	9	6	10
22. Ala. Polyt. Inst.	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	1	3	7	4	9	5	4	3	3	4	2	3	7	12	6	....	2
23. Me. Agr. Coll.	....	....	....	....	....	....	....	....	....	....	....	....	4	4	10	9	7	5	4	7	3	9	5	5	5	5	10	10	6	4	11	8	9
24. Iowa Agr. Coll.	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	4	5	1	5	3	....	4	1	4	9	6	4	5	3	5	1	8	10
Totals, Group C	....	....	....	....	....	....	....	....	....	....	10	17	24	32	42	37	46	39	33	34	25	32	27	32	42	40	47	44	48	38	49	40	50
25. Univ. of Pa.	....	....	....	....	....	....	....	....	....	....	....	....	....	2	9	6	8	3	6	5	8	10	5	8	14	5	14	14	15	9	9	8	3
27. " " Wis.	....	....	....	....	....	....	....	....	....	....	....	....	....	3	1	3	4	5	1	....	3	3	3	5	4	6	2	2	3	4	5	8	7
28. Dartm (Thayer)	....	....	....	....	....	....	....	....	....	....	....	....	....	2	2	3	2	4	1	3	2	2	2	3	2	4	1	2	4	3	2	6	4
29. Swarthmore	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	5	4	1	4	3	2	2	1	5	3	1	3	4	10	6	5	6	7
31. Univ. of Mo.	....	....	....	....	....	....	....	....	....	....	....	....	....	2	1	2	1	2	1	....	1	4	....	3	1	2	2	....	....	1	1	1	2
32 " " Cal.	....	....	....	....	....	....	....	....	....	....	....	....	....	7	8	11	3	2	11	5	1	4	5	5	1	....	7	1	4	5	5	7
33. " " Kans.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	....	....	....	1	1	....	2	2	1	2	1	6	3	6	1	3
34. " " Minn	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	3	....	....	2	....	....	....	....	2	4	3	....	1	1	1	9	4	2
35. Rutgers	....	....	....	....	....	....	....	....	....	....	....	....	....	11	2	13	7	7	3	9	5	2	8	6	10	8	8	8	10	8	8	8	8
36. Univ. of Ia.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	3	....	3	....	3	2	3	4	4	2	7	5	1	8	6	9	5
37. Cornell (Iowa)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	1	3	2	3	3	1	2	3	2	1	8	4	8	8	1	9	1	9
38. Univ. of Ill.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	1	2	3	2	4	6	4	4	4	4	1	9	12	11	11	11
39. " " Cinc	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	5	1	2	3	1	1	....	....	1	1	1	3	4	2	2	2
40. Princeton	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(6)	5	5
Totals, Group D	....	....	....	....	....	....	....	....	....	....	7	23	41	41	32	40	45	38	44	38	48	64	38	52	66	60	54	85	79	73	73	73	73
41. Texas Agr. Coll.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	4	10	4	6	12
42. Univ. of Neb	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	3	..	....	1	1	2	1	....	3
43. Colo. Sch. of M.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....
44. W. Univ. of Pa.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	4	2	3	4	2	4	7	12
45. Pa. State College	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1	1	(5)	(10)	4	10
46. Purdue	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	7	3	8	5
47. Rose Polyt. Inst.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	4	4	3	2
48. Univ. of Tex.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	2	1	2	6
Totals, Group E	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	1	....	2	5	4	3	5	17	32	27	30	50
Gd. Totals	32	39	29	30	23	45	45	57	73	69	86	117	110	153	191	230	226	216	188	188	157	188	148	175	234	202	251	273	305	261	337	306	371



OFFICIAL PROFILE OF THE OTIS ELEVATING CABLE

Note: A considerable number of emendations, corrections and additions have been received, which are held over until they can all be given at once. All such will be embodied in the reprint in book form of these articles. Table XVIII., giving the mechanical engineering graduates is also held over until our next issue.

by turbines to operate the cables. The power is supplied by two of Thury's dynamos operated by turbines situated about 1,400 ft. below the summit station, to which it is transmitted by copper wires and there reconverted into mechanical energy. The cable incline up the Monte San Salvatore, at Lugano, Italy, which was fully described in our issue of April 21, 1892, is the only other using electric motors to operate the cables.

By far the longest cable inclines in the world are located in Italy. The older and better known of these is the line to the summit of Mt. Vesuvius, which is 10,500 ft. long. This line, however, is operated in two divisions, 6,900 ft. and 3,600 ft. long, respectively, the power house for both divisions being located at the Atrio del Cavallo at the end of the first division, where the passengers are also transferred from one line to the other. The other line ascends the Supurga, near Turin, Italy, on which is located the sepulchral chapel of the Italian royal family and is 10,243 ft. long. The grades on this line are comparatively low, the maximum being only 20%, and this for a short distance only. A very full description of this line was given in our issue of June 19, 1888.

Aside from the Otis Elevating Ry. up the Catskills and the Lookout Mt. Incline in Tennessee, which was described in our issue of Jan. 7, 1888, the most important cable inclines in this country are located at Pittsburg, Pa., and Cincinnati, O. The first ever built are in San Francisco (Eng. News, April 4, 1878; Nov. 10, 1883), but the inclines are neither very high nor very steep. There are quite a number of isolated plants in the Pennsylvania coal mining regions and in different localities. Such of the more important cable inclines as we have been able to collect details of in a hasty examination are given in the following table, to which we add details of the new Catskill Mountain line for comparison.

Name and Location.	Length on incline, ft.	Total rise.	Gr'd per c.	Gage. feet.
Mt. Vesuvius, Italy	10,500	.....	m'x63	.....
Mt. Supurga, "	10,243	.....	" 20	.....
Catskill Mountain, New York	7,000	1,630	" 34	3.0
Mt San Salvatore. Italy	5.358	1,973	" 60	3.28
Lookout Mt., United States	4,360	1,170	.....	3
Burgenstock, Switzerland	3,071	1 444	" 57	3.28
Knoxville, Pittsburg, U. S.	2,640	375 av	13.8	9
St. Clair, " "	2,060	361	" 14.2	7
Penn, " "	840	330	" 39.2	10
Duquesne, " "	780	400	" 58.5	5

As compared with other incline railways to overcome mountain heights the Otis Elevating Ry. up the Catskills is in some respects a new departure. It starts from Otis Junction, on the Catskill Mountain Ry., and runs directly to the summit of South Mt., near the Catskill Mountain House. It is of the three rail type, the middle rail being common to both tracks, and one train ascends as the other descends. The trains pass each other about midway on the line where a fourth rail is introduced for a distance of about 100 ft., making a turnout. The total length of the line on the incline is 7,000 ft., and its total rise in that distance is 1,630 ft. A general profile of the line is given in Fig. 1. The maximum grade is 34%, and the average grade is about 12%. The gage of the track is 3 ft., the same as that of the Catskill Mountain Ry., with which it connects.

With the exception of the turn outs the road runs in a straight line from end to end. In respect to its grade line, however, the road is decidedly novel.. This is composed of a series of vertical, compound, circular and parabolic curves so designed that the trains with equal loads exactly balance each other at all points on the line. This method of compensating for differences in weight between a long and short cable, and thus keeping the force exerted by the engines constant, is familiar to engineers, and in many cable railways the natural slope of the ground has aided in its partial application, but this is, we believe, the first time in which the principle has been put into practice on a work of any magnitude. The credit for this innovation is due to Mr. Thos. E. Brown, M. Am. Soc. C. E., the designing engineer.

Surveys for the line were begun in December, 1891 The grading, earth and rock work were finished early this year. Beyond the large rock cuts and the natural difficulties of the ground there was nothing worthy of especial notice in this work.

Throughout the entire length of the road, with the exception of 1,000 ft. at the lower end, where the rails are laid on cross ties with broken stone ballast, the rails and ties are laid on a timber superstructure. We may note that all the stone used for ballast and for the masonry in the foundations for the various buildings and for the trestle bents was obtained from the rock cuts along the line. It is a blue stone of a slaty structure, such as is commonly used for flagging, in which is imbedded nodules of some trap like stone, and it is apparently very durable. With the exception of the trestles the timber superstructure consists of two courses of longitudinal timbers 6×10 ins., laid on subsills placed 6 ft. apart, c. to c., and supporting 6×6 in.×8 ft. crossties, spaced 2 ft. c. to c. The crossties are gained into the longitudinal timbers, and between each is a block of scantling 6 ins. thick spiked to the longitudinal to prevent any tendency of the rails and ties to creep. The total length of trestling on the road is between 2,500 and 2,600 ft., and its maximum height is 72 ft. The construction of the trestle bents and the arrangement of the track are shown in Figs. 2, 3 and 4. The rails weigh 35 lbs. to the yard, and are laid with suspended joints with 4 bolt angle bars slotted to receive the spikes.

From the contractor's point of view the building of this timber superstructure and the track-laying and trestle work were the most difficult parts of the work. Owing to a delay in securing the timber this work did not begin until May, some time after the contractors had arrived on the ground. Meanwhile, however, work was begun changing the line of the Catskill Mountain Ry., by moving it some distance toward the mountain in order to obtain the grade necessary to operate the incline. All the timber used was Southern pine, shipped from the South to New York and transferred to lighters for Catskill, and thence shipped by rail to Otis Junction. The necessary framing was done at the foot of the mountain and the timber hauled by team to its position. Owing to the rugged and precipitous character of the mountain side this work was very difficult and expensive, necessitating the use of block and tackle in many places. Even with this loads of only about 500 ft. B. M. could be hauled. It is stated that the cost of hauling some of the timber from the foot of the mountain to the point of erection was $15 per 1,000 ft. B. M. Considerable trouble was also experienced in laying the track on the steep grades, the heavy longitudinal timbers and rails developing a marked propensity for unexpected journeys to the foot of the mountain. This work, however, was completed by the contractors, Messrs. Mairs & Lewis, 18 Broadway, New York, without any serious accident, either to property or employees. The same firm also had the contract for the terminal stations and the machinery and boiler houses. About 1,250 M. ft. B. M. of timber were used in the various trestles and superstructure.

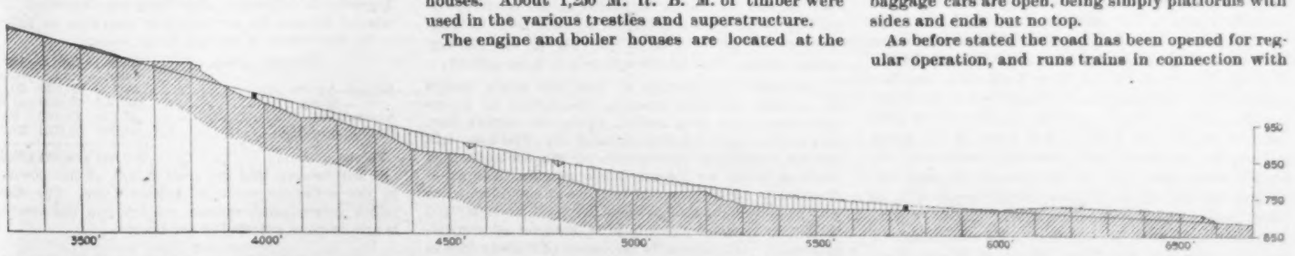
The engine and boiler houses are located at the upper end of the line, the latter being at one side of the track some 50 ft. away from and below the level of the engine house. Steam is supplied by two 150-HP. Manning patent vertical tubular boilers, each containing 152 tubes 15 ft. long and 2¼ ins. in diameter, with a total heating surface of 1,563 sq. ft. The total height of the boilers from the floor line to the top of the bonnet is 22 ft. 10½ ins., and their diameter at the waist is 56 ins. The thickness of their shells is ⅝ in. and of their heads ⅞ in. The outside diameter of the furnaces is 73 ins., the inside diameter 66 ins., and the height 44 ins. The boilers were tested to 200 lbs., and will be run under a pressure of 125 lbs. They were furnished by the Q. N. Evans Construction Co., of New York city. In connection with the boilers the same company furnished a smokestack 72 ft. high and 48 ins. diameter.

We expect to give full details of the hoisting machinery in a future issue. In brief, however, we may say it consists of two 12 × 30 in. Hamilton Corliss reversing engines geared in a ratio of 22 to 100 to one of two Walker differential winding drums, each 12 ft. in diameter and placed tandem. Cut-off at one-fourth stroke the engines are rated at about 80 HP. each. They are controlled by the throttle valve, reversing lever and the brakes, in addition to the usual cut-off gear. The levers operating the friction brakes and the reversing gear and controlling the steam are located in the operating tower from which a full view of the entire line is had by the operator. The cables, two in number, are of steel, with a hemp center 7,250 ft. long and 1¼ ins. in diameter, and weigh 2½ lbs. per lin. ft. The ends of the two cables are attached to the two trains of cars. The car on the right track ascending the cables pass from the right track to the winding drums which they encircle twice, and thence to an inclined sheave 8 ft. in diameter in the rear of the building which transfers them to a guiding sheave, and thence to the left track. Of course this order is reversed when the left car is ascending. The shifting sheave is placed some distance to the rear of the drums and is supported by massive timbers anchored to the rock with drift bolts 15 ft. long and 1½ ins. thick. Steam is transferred from the boilers to the engine by a pipe 5 in. in diameter. The cables are supported along the track in the usual manner by ground idlers placed 30 ft. apart, its weight being sufficient to keep it in place.

On a road of this kind the precautions taken to prevent accidents are of course especially important. In addition to the safety clutches on the cars, details and descriptions of which we defer until another issue, each of the engines is fitted with a strap or friction brake operated from the operating tower, as noted before. The main hoisting drum also has a strap brake which is to be connected with an automatic stop, to prevent the car from overrunning its proper position at the top of the incline. The two terminal stations and each car are connected by electric gong signals.

The rolling stock used on the line is very simple. It consists of four cars; two for passengers and two for baggage. Each train is made up of a passenger and baggage car. The passenger cars were furnished by Jackson & Sharp, of Wilmington, Del., and are 46 ft. long and 7 ft. 6 ins. wide, built on an angle of 10° 30'. They can seat comfortably 75 persons, and with crowding 90 persons. They weigh 22,000 lbs. each, and are provided with stationary seats said to be the counterparts of those used in the elevators of the Eiffel Tower. Each is mounted on two 4-wheel trucks provided with the ordinary hand brakes. The baggage cars are open, being simply platforms with sides and ends but no top.

As before stated the road has been opened for regular operation, and runs trains in connection with the regular trains on the Catskill Mt. Ry., and the steamboat lines on the Hudson River. Its upper terminus is within a few rods of the Catskill Mountain House and from it the most popular summer resorts of the mountains can be reached by a short



RAILWAY UP THE CATSKILL MOUNTAINS.

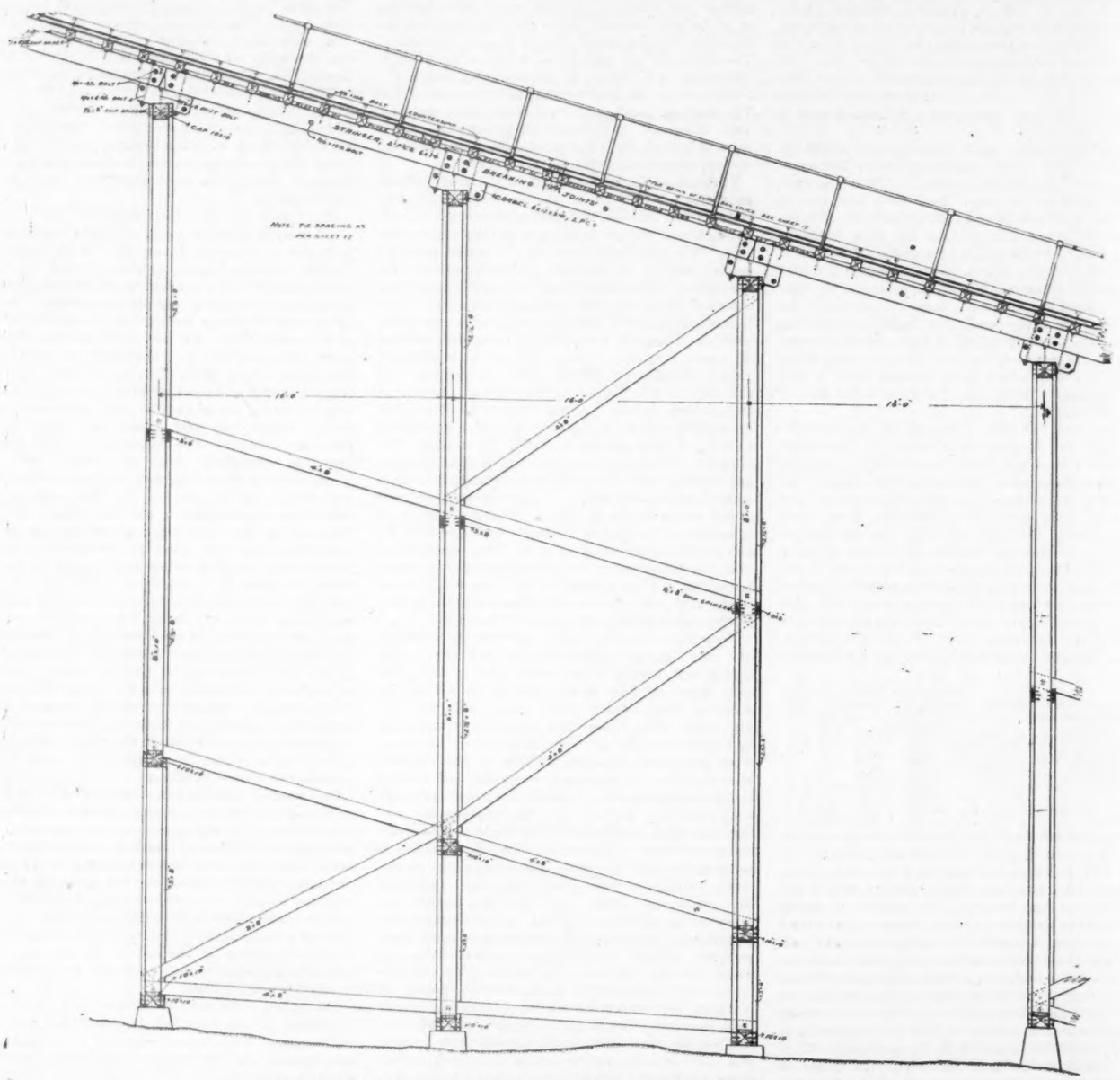


FIG 1. SIDE ELEVATION OF TRESTLE BENTS; OTIS ELEVATING CABLE RY.

drive, and in about four hours' time from New York city. The ascent of the incline is made in about 10 minutes, or at the rate of about 700 ft. per minute.

The road was built by the Otis Elevating Ry. Co., of which Mr. Chas. L. Rickerson is President, C. C. Hager, Secretary and Treasurer, and Chas. A. Beach, Superintendent. Its total cost was $275,000. The general contractor for its construction was Chas. L. Bucki, of New York, who sublet the grading to Pennell, O'hern & Co., of New York; the trestles, tracklaying, buildings and timber work to Mairs & Lewis, of New York, and the machinery to Otis Bros. & Co., of New York. Otis Bros. & Co. again sublet the engines and hoisting machinery to the Walker Mfg. Co., of Cleveland, O., and the boilers to the Q. N. Evans Construction Co., of New York. The chief and designing engineer was Mr. Thos. E. Brown, M. Am. Soc. C. E., who designed the elevators for the West Shore R. R. at Weehawken, N. J. (Eng. News, Jan. 17, 1891). The assistant engineers were Mr. W. G. Howell, of Washington, D. C., and Mr. Gaylord Thompson and Mr. Chas. F. Parker, of New York, and the engineer for Mairs & Lewis was Geo. C. MacGregor. We are indebted to Mr. Brown and the two last named gentlemen for the details of the work given herewith.

EXPORTS OF BRITISH RAILS.

According to a recent article in "Engineering," of London, there is considerable depression in rail manufacture for the colonies and general export trade. If the colonies should take up economical railway construction for the development of the country, according to the system referred to in our issue of Aug. 4, there would be a large increase in the railway supply trade. The article referred to is as follows:

Depression still prevails in well nigh every branch of our iron and steel exports. The falling off in the shipments is the most marked as regards railway iron, the foreign and colonial demand for which is still greatly reduced in consequence of the contraction of credit to which we recently made allusion. The disinclination to advance capital to some of our colonies, as well as to certain foreign countries, still prevails; and until it is removed there is little prospect of any improvement. Our aggregate shipments of railway iron to June 30, this year, amounted to 193,417 tons, as compared with 384,548 tons in the first half of 1891, and 576,019 tons in the first half of 1890. It will be seen that the deliveries for the first half of this year were little more than one-third as large as those made for the first half of 1890. The exports of British rails have somewhat increased this year to Sweden and Norway, Spain, China, and Mexico, but in every other direction a more or less marked falling off is observable. The deliveries of British rails to the Argentine Republic in the first half of this year were only 10,046 tons, as compared with 67,574 tons and 182,399 tons in the corresponding periods of 1891 and 1890 respectively. There has, at present, been no recovery in Argentine credit; and this being the case the falling off in our rail shipments to Argentina is only what might have been expected. The colonial demand for our rails has moved on as follows in the first halves of the last three years:

Colonial group.	1890. tons.	1891. tons.	1892. tons.
British Africa	37,150	39,320	20,944
" India	140,566	76,869	41,868
Australasia	46,199	48,672	9,950
British America	28,646	35,073	28,282
Totals	252,561	199,934	101,094

It will be seen that the great falling off has occurred in the deliveries made to British India. The check which Australasian railway construction has received is also sharply reflected in our figures.

Following close on the labor troubles at Homestead comes a strike of the railway switchmen at Buffalo, on the Lehigh Valley, New York, Lake Erie & Western, New York Central and West Shore roads, which at present seems somewhat likely to extend to many other points, and has already caused serious interruptions to traffic. The root of the difficulty is that Buffalo is the dividing point between the Chicago scale of wages and that in force on the Eastern roads. This fact makes a settle-

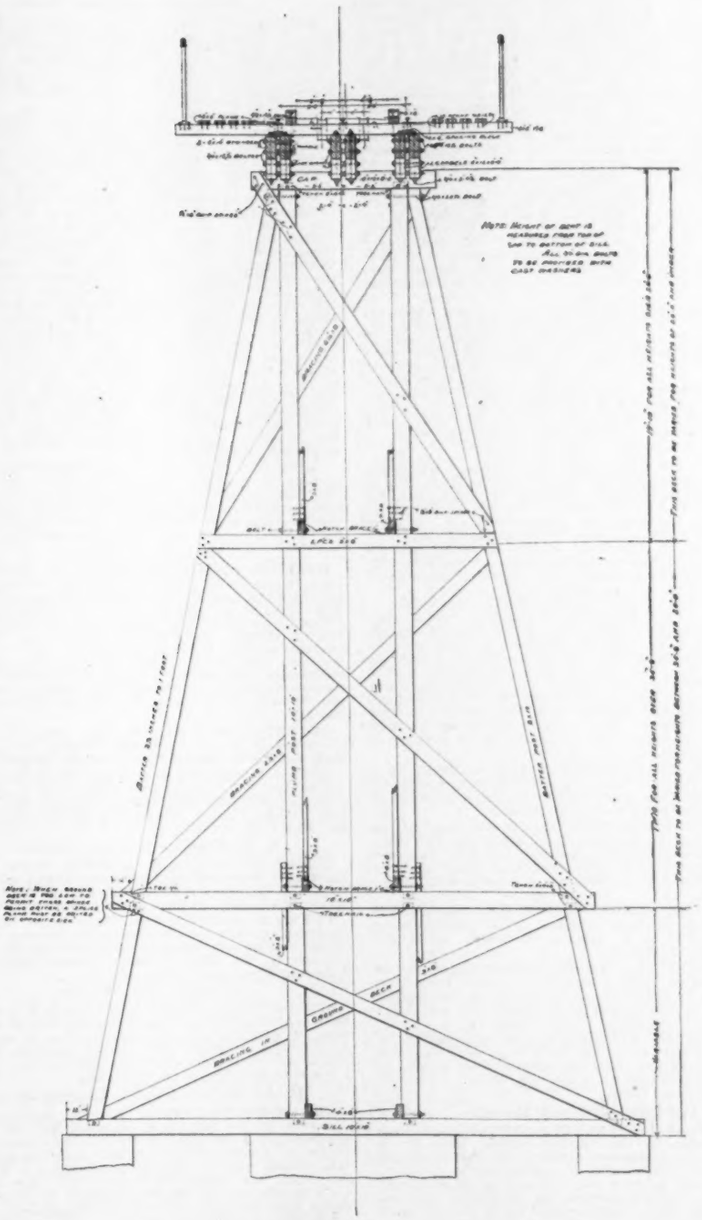


FIG 2. END ELEVATION OF TRESTLE BENTS.

ment of the dispute a difficult matter. The men are not likely to be permanently contented, while they have lower wages and longer hours than the men just west of them, and on the other hand the railways cannot concede what is asked at Buffalo without having the same demands made all along their lines and at their Eastern terminals. The strike, like most switchmen's strikes, has been a particularly bad one in the way of violence and destruction of property. Many fires have been set among the cars in the Buffalo yards and troops numbering about 2,000 have been put under arms to afford protection from the rioters.

The Darling Harbor bridge competition (Sydney, N. S. W.) resulted as follows, the Minister of Public Works announcing the decisions of a Board of Adjudicators: First premium ($3500) to Mr. A. C. Pain, Mr. Inst. C. E., Engineer, Tottenham & Forest Gate Ry. and Mr. J. R. Lilgesquist, A. M. Inst. C. E., who competed together; second premium ($1500), Mr. John J. Webster, M. Inst. C.E., London; third premium ($1,000), Mr. Alfred M. Howarth and Mr. Carl Dalgard, C. E., of the Technical University of Stockholm. The competitors named as next in order of merit were Mr. Max Am. Ende, of London; Mr. Chas. A. D'Ebro, of Melbourne; and Mr. J. A. L. Waddell, of Kansas City, U. S. A. There are said to have been 38 designs in all. It was a cold day for American engineers, only one receiving even honorable mention, but if it had been a competition on the business basis of agreeing to meet specified requirements at a specified cost, the result might have been widely different, as with the Hawkesbury bridge.

The survey for a meter gage railway from the east coast of Africa to the Victoria Nyanza has been completed to Kikuyu, a distance of 300 miles from the coast. The route thus far surveyed is said to run for the most part through populous and cultivated districts. The engineers estimate the total cost of the construction and equipment at $15,000 a mile, or a little over. $6,000,000 altogether.

The prices of bids for 1,022 tons of steel ties recently received by the management of the Hanover State Railways, Germany, ranged from $27 to $31.50 per ton.

A French torpedo boat built by M. Normand, of Havre, recently attained an average speed of 23.585 knots on the measured mile on her contract trial. The boat had a displacement of 76 tons, and during the test had her full armament and a good coal supply on board.

The Naval Appropriation bill contains an item of $50,000 for experiments with a wire-wrapped gun for firing high explosives.

It is proposed to utilize the existing mains of the Birmingham (England) Compressed Air Co., for the distribution of fuel gas. The compressed air plant was obliged to suspend operations some time ago, and the mains have since then been unused. It is pointed out that by distributing heating gas through the mains small manufacturers could obtain their heat for furnaces as well as their power from a central station.

An electric stone crusher has been placed on the market recently by the mining department of the Thomson-Houston Co. The machine consists merely of an electric motor driving an ordinary stone crusher by spur gearing.

The effect of color upon the temperature of railway cars is being discussed in India, and the "Times of India" says that railway traveling in India during the hot weather, in spite of many conveniences provided by the companies, is not only very fatiguing for the average traveler, but positively dangerous to many. The cars are exposed to the sun during the whole

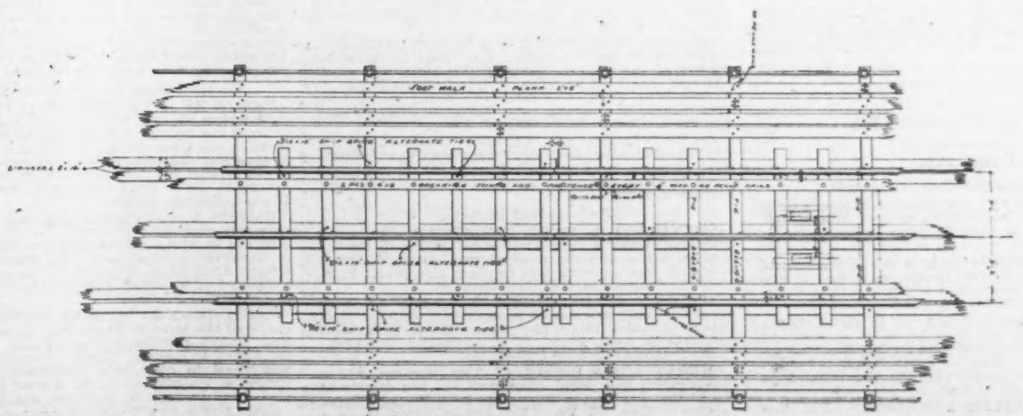


FIG. 3. PLAN OF FLOOR SYSTEM.

of the day, and being constructed largely of iron, including the outer roof, they are heated up like ovens, while the arrangements for cooling them have never been satisfactory even to the companies who own them. The "Indian Engineer" says in this connection that one simple means of keeping down the temperature has been neglected in a manner that seems difficult to explain. Although white is known to be the color that resists most effectually the heat of the sun, it is the color the least used on the exterior of railway cars, and although black and the darker shades of brown and grey are known to absorb the most heat, they are largely used on the roofs and sides. There is a steady increase of heat absorbing power in all the colors extending from white to black, which absorbs more than twice as much heat as white. In a letter from the Superintendent of the Northwestern Ry., in our issue of June 9, it was stated that the cars of that road are painted white, green and yellow for first, second and third class, respectively.

By a collision in the channel entrance to the harbor of Helsingfors, Finland, on Aug. 8, an excursion steamer was wrecked and 86 of those on board her were lost. The collision was caused by the excursion boat attempting to cross the course of another steamer as the two vessels were approaching each other.

Experiments on the shocks to rolling stock, caused by the space between the ends of rails at the joints, have recently been made in Germany, according to the "Engineer," of London. On a side track, in good condition, notches were cut in the rail heads at points directly over the cross ties, measuring 0.12-in. in depth, and from 0.6-in. to 1.2-ins. in width, and trial runs with a locomotive and observation car were made over the section thus prepared. It was found that observers on the engine experienced distinctly noticeable shocks only with the notches 1.2 ins. wide, while observers stationed alongside the track could scarcely discern the special noise produced by the passing wheels. Increase of speed seemed, if anything, to diminish the noise and the magnitude of the shocks. The instruments in the observation car failed to give any records. This does not quite accord with English experience, the "Engineer" thinks, the effect of running over turned double-head rails, for example, being very apparent.

Some of the reasons for different prices of bids for the same class of paving in different cities are given in the following published statement of Mr. G. C. Warren, of the Warren-Scharf Asphalt Paving Co., in regard to the paving bids recently submitted at Utica, N. Y.:

Hitherto our bid in Syracuse for the same pavement laid in Utica has been $2.70, but in that city 30 cts. per cu. yd. is allowed additional for excavation. That would make the actual bid as compared with those in Utica $2.85. Our bid this year in Syracuse was without the guarantee, which for five years is counted at 9 cts. per sq. yd, leaving our bid there at $2.76 per sq. yd. In addition, it should be said that sand is 22 cts. per cu. yd.. and broken stone 35 cts. per cu. yd. less in Syracuse than Utica, so that, really, our bids in Utica are lower than those in Syracuse by several cents. In Rochester we bid $2.50 per sq. yd. for "light standard," the same as we offered to lay here at $2.45, and will be glad to carry out contracts at that figure. Our bid in Utica this year is $2.81. In Binghamton we bid $2.83; in Amsterdam, $2.90; in Troy, $2.90; in New York City we get considerably more than $3.00 per sq. yd.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Brakeman's Death Caused by Telltale.

That a railway company's "telltale," thought safe for cars of an ordinary height, was dangerous for brakemen upon cars of a greater height, which have come into use for special purposes, shows a breach of the company's duty to provide its employees with safe appliances, and a danger not manifest or a risk ordinarily incident to a brakeman's employment. (Darling v. N. Y., P. & B. Ry. Co., Supr. Ct. R. I., 24 At. Rep., 462.)

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

TUSCARORA VALLEY.—Construction is now in progress on this railway from Milford to Lock Haven, Pa., and it is expected to have 15 miles in operation by Oct. 1.

CONCORD & MONTREAL.—At a recent meeting of the stockholders of the New Boston R. R. Co. it was voted to begin the construction of its line from Goffstown to New Boston, N. H., 5¼ miles.

INDIANA, ILLINOIS & IOWA.—It is stated that a stockholders' meeting will soon be called to complete arrangements for letting contracts for building the proposed extension from Knox to South Bend, Ind., surveys for which were completed some time ago. It is hoped to begin work about Sept. 1.

FINDLAY, FT. WAYNE & WESTERN.—The line of this road has been graded, except the surfacing, as far west as the Indiana state line.

PITTSBURG & WESTERN.—The Baltimore, Md., "News," says: The Baltimore & Ohio R. R. is preparing to rebuild and shorten the Pittsburg & Western road, of which it secured control last year. The work will necessitate an expenditure of from $3,000,000 to $4,000,000. The company has also chartered the Allegheny & Lawrence R. R. Co., which is to build a line from Bryant, Allegheny Co., to Moravia, in Lawrence Co., a distance of 40 miles. By the construction of this new road, which will use the tracks of the Pittsburg & Western in many places, that line will be shortened about seven miles and get rid of the heavy grades which have been an expense to the road. The old grades were 100 ft. to the mile, while the new line will be about 36 ft. to the mile. The new road will have two expensive tunnels, one of which will be 2,300 ft. long, and it is estimated that it will cost nearly, if not quite, $100,000 a mile. It is expected that work will be begun soon after the return of President Mayer from Europe, but owing to the heavy work to be done it will probably take two years to finish the new line. The road will be double-tracked, laid with heavy steel rails and built in the most substantial manner.

SANDUSKY & COLUMBUS SHORT LINE.—It is expected that the line from Bellevue to Columbus, O., will be completed by Nov. 1. The authorized issue of bonds is $3,000,000, of which amount $2,125,000 were set aside for construction purposes and have already been sold. In order to provide the necessary equipment the Board of Directors have authorized the sale of $700,000 of their first mortgage bonds at 90 and accrued interest, with a bonus of $250 of the full-paid capital stock of the company with each $1,000 bond.

Projects and Surveys.

TROY & NEW ENGLAND.—The company which has engaged to construct this road from the state line to Troy, providing $100,000 in stock be subscribed for in Troy, N. Y., and the right of way obtained through the city, is the Raymond Construction Co., of New York. It is stated that Jas. Raymond, the President of the company, is organizing a corps to verify surveys of the proposed route with the object of lessening the grades as much as possible. Local levelers, chain bearers and rodmen will be engaged, and the work of surveying will be pushed forward as rapidly as possible.

FORT PLAIN & RICHFIELD SPRINGS.—This company, noted in our issue of Aug. 4, has been incorporated in New York, with a capital of $300,000 to construct a standard gage steam railway, about 30 miles long, from Fort Plain to Richfield Springs, with a branch to Palatine, Montgomery Co. The directors are William Clark, John D. Wendell, W. E. Diefendorf, David G. Hackeny, and Edward S. Van Deusen, of Fort Plain, S. R. Stewart, of Springfield Centre, and Norman Getman, E. B. Weatherbee, and Myron A. McKee, of Richfield Springs.

COBOURG, NORTHUMBERLAND & PACIFIC.—It is stated that Ferris & Richards, of New York, constructing engineers, have contracted to construct 50 miles of this road from Cobourg, Ont., northeast.

LA FAYETTE & MONON.—This is the name of the belt railway at La Fayette, Ind., which the Belt Ry., Land & Improvement Co. proposes to build. The preliminary surveys have been completed. Pres., Adams Earl; Vice-Pres., W. F. Stillwell, and Secy. and Treas., James Buck.

HUDSON CO. CONSTRUCTING CO.—Chartered in New Jersey to construct railways. P. L. Behill, Jersey City, N. J., and K. K. Stearns, Elizabeth, N. J., are among the incorporators.

McKEESPORT & WILMERDING.—Chartered in Pennsylvania to build a railway 3½ miles long from McKeesport to Wilmerding, Pa. Pres., A. W. Smith; Secy., John C. Devemy, of McKeesport, Pa., and Vice-Pres., B. W. Carskaddow, Wilkinsburg, Pa.

SOUTHBRIDGE, STURBRIDGE & BROOKFIELD.—The local papers state that work is in progress clearing the right of way for this railway from Brookfield to Southbridge, Mass., 13 miles. Ch. Engr., Arthur P. Moore, Sturbridge, Mass.

Southern.—Existing Roads.

CHARLESTON, CINCINNATI & CHICAGO.—William Kenefick writes to the "Manufacturers' Record" in reference to the statement, lately made, that contracts had been awarded to himself and others to complete this road from Johnson City, Tenn., to Minneapolis, Va., that the report is correct, but no special time has been fixed for the commencement of work, although it will no doubt begin some time during September.

OWENSBORO, FALLS OF ROUGH & GREEN RIVER.—The contract for building the 16-mile extension from Fordsville, Ky., to Horse Branch, Ky., has been let.

NORFOLK & WESTERN.—Work is in progress upon the first mile of the belt line at Lynchburg, Va.—Less than 30 miles of track remain to be laid to complete the Ohio extension of this line.

BRISTOL, ELIZABETHTON & NORTH CAROLINA.—The city of Bristol, Tenn., has voted to subscribe $40,000 of the capital stock of this company, which has just completed 20 miles of railway from Bristol to Elizabethton, Tenn. The road is projected to run from Elizabethton to Mountain City, Tenn., 40 miles further. Ch. Engr., Geo. S. Bruce, Bristol, Tenn.

JACKSONVILLE, ST. AUGUSTINE & HALIFAX RIVER.—The extension from Daytona to New Smyrna, Fla., 16 miles, has been graded ready for the rails, and work is being actively pushed on the line from New Smyrna to Titusville, Fla.

Projects and Surveys.

OWENSBORO & WEST LOUISVILLE.—This road has been surveyed from Owensboro to Beech Grove., Ky., 20 miles, and the right of way obtained, but it is stated that no work will be done this year. R. S. Triplett, Owensboro, Ky., is interested.

DALTON & SPRING PLACE.—A company has been formed to build a standard gage dummy railway from Dalton to Spring Place, Ga. Second hand, light, steel rails will be used. Pres., F. T. Reynolds; Vice-Pres., P. B. Trammel; both of Dalton, Ga.

CHERRY RUN & POTOMAC.—This company, whose incorporation was noted some time ago has completed the preliminary survey for its line from Harper's Ferry to Cherry Run, W. Va. The line is stated to be a Baltimore & Ohio project. C. McK. Watts, of Pittsburg, Pa., is in charge of the surveys.

Northwest.—Existing Roads.

GREEN BAY, WINONA & ST. PAUL.—The Green Bay, St. Paul & Minneapolis R. R. Co. has been chartered in Wisconsin to build the extension to St. Paul, Minn., previously noted. According to the charter the route will be from Alma Center, Wis., to a point on the St. Croix River and thence to St. Paul, Minn. Surveys are now in progress.

ILLINOIS CENTRAL.—At the annual meeting of the stockholders of this company to be held Oct. 12, the directors will submit a proposition to the stockholders to increase the capital stock by $5,000,000. The capital stock now stands at $45,000,000, and the new increase will make it $50,000,000. The privilege is given stockholders to subscribe for this new stock at par, and arrangements have already been made for the sale at par of such of the new shares as may not be subscribed for by the present stockholders. The directors recommend the increase of the capital stock in order to meet the large outlays which will be imposed upon the company on account of the expenditure on the new depot and office buildings at Chicago, and to prepare for the expected business of the World's Columbian Exhibition in 1893. The expenditures are estimated to be as follows: For passneger depot and general offices, $1,000,000; for elevation of tracks, etc., $1,000,000; for equipment and other expense in connection with the World's Fair, about $2,000,000; cost of erection of new shops at Burnside, interlocking at grade crossings, system of block signals between Chicago and Kensington, construction of elevator at New Orleans, new freight house and trainshed for the new passenger station at New Orleans, and other matters, estimated at about $1,000,000; a total of $5,000,000.

YANKTON, NORFOLK & SOUTHWESTERN.—The grading on the division from Yankton, S. Dak., to Wausau, Neb., 30 miles, will be completed in about a week and tracklaying will begin Sept. 1. The contract for the 34 miles from Wausau to Norfolk, Neb., has been let to Wm. Larson, who will commence work at once.

Projects and Surveys.

ILLINOIS SOUTHWESTERN.—This company has been chartered in Illinois to build a railway from a point on the line of the proposed Chicago & New Orleans Ry., at or near the line between Jefferson and Franklin counties, Ill., thence in a southwesterly direction through Jefferson, Franklin and Williamson counties to some point in Jackson Co., at or near Carbondale. The principal business office is to be located at Chicago, and the capital stock is $1,000,000. The incorporators are R. A. Wade, D. R. McCutcheon, D. M. Sill, Wesley Briggs and Charles E. Wyman, all of Chicago.

EVANSTON CITY RY. CO.—This company has been chartered in Illinois by Henry Delany, Rich. A. Paddock and Jos. P. Coody, with a capital stock of $150,000.

IOWA.—A project is on foot to build a railway from Ames, Ia., via Tunnel and Homer, to a connection with the Webster City & Southwestern R. R., at or near Border Plains. W. B. Wilson, of Cedar Rapids, Ia., and J. L. Stevens, of Ames, Ia., are interested.

Southwest.—Existing Roads.

TEXAS, LOUISIANA & EASTERN.—Seven miles of track have been laid on this railway from Conroe, Tex., east, and 12 miles more are graded ready for the track, which will be laid as soon as the necessary rails arrive.

TEXAS & PACIFIC.—Res. Engr., B. S. Wathen, of Dallas, Tex., has received orders to prepare estimates of the cost of completing the Denison, Bonham & New Orleans R. R., partly graded, between Denison and Bonham, Tex., some years ago.

Projects and Surveys.

SPRINGFIELD, SEDALIA, MARSHALL & NORTHERN.—At a recent meeting of the directors of this company it was decided to build the line at once from Miami to Springfield, Mo., on the condition that the people along the route grant the right of way and raise a bonus of $280,000, in aid of the line.

Rocky Mt. and Pacific.—Existing Roads.

GREAT NORTHERN.—At a recent meeting of the directors of the Seattle & Montana Ry. Co. it was decided to expend about $250,000 in terminal improvements at Seattle, Wash. A very large proportion of this money will be used in constructing a four-track line from the company's grounds near the Transfer Co.'s warehouses to the shop grounds on Gilman's addition between Smith's Cove and Salmon Bay.

NELSON & PORT SHEPPARD.—It is stated that arrangements have been made for building this line. The arrangement made is that surveys are to be completed this fall and active construction work commenced as soon as possible next year. The route is from the Spokane Falls & Northern Ry., at the boundary north, across the Pend d'Oreille River, along the Columbia River to Beaver Creek, thence to the main Salmon River and along the western forks of the same to Cottonwood Smith Creek, thence by a six or eight-mile detour into Nelson City. The whole length of the line is about 120 miles. Pend d'Oreille River is to be bridged this winter so as to be ready for use next summer.

Projects and Surveys.

NAMPA RY. & CONSTRUCTION CO.—A correspondent writes us that this company has been chartered to build the railway from Nampa to Silver City, Idaho, noted in our issue of July 21, and that surveys are now in progress. The line is being surveyed in the interest of Pittsburg, Pa., and New York capitalists. Pres., Pringle C. Jones, South Charleston, O.; Ch. Engr., T. D. Babbitt, Nampa, Idaho.

IDAHO.—A press dispatch says that a wealthy syndicate was recently formed for the purpose of building railways in Idaho and is already making preparations to construct a broad gage road from Weiser, on the Oregon Short Line, to the Seven Devils mining region, a distance of 90 miles. Later the road will be extended to Lewiston.

WASHINGTON & COLUMBIA RIVER.—This company has been chartered in Washington to build railway lines from Hunt's Junction to Puget Sound, and from Pleasant Valley to Riparia, Wash. The new incorporation is understood to have been incorporated to secure the Oregon & Washington R. R. Among the incorporators are: Levi Ankney, W. D. Tyler, and F. W. Paine.

SAN LUIS & SAN JOAQUIN.—Chartered in California

to build a railway from San Luis, Obispo to El Moro, Cal., about 10 miles.

Foreign.

HONDURAS.—It is stated that Mr. C. P. Huntington will probably take an active interest in the construction of a railway through Honduras from the Atlantic to the Pacific Ocean. Mr. Barrett H. Van Auken has a valuable concession, and he and others have had conferences with Mr. Huntington, who is inclined to regard the project with favor. Mr. Huntington is reported as saying that nothing had been settled as yet and he could not tell just how much of an interest he would take in the scheme. He told the parties to go ahead and prepare plans, and when they could tell just what they had got they might be able to make some arrangements. There are already two small roads in existence in Honduras, which can be utilized in this project. The length of a railway across the isthmus there would be a little less than 200 miles.

MEXICAN SOUTHERN.—Track has been laid to kilometre 73 from Tecomavaca, leaving but 70 kilos. to build before reaching Oaxaca. In this distance there is but one bridge of any importance to construct, the remainder of the work being plain tracklaying. Mr. Campbell, the contractor, states that they will certainly have the line completed to Oaxaca by Oct. 15, if not before. It is intended to finish the line to the port of Salina Cruz, on the Pacific coast.

ELECTRIC RAILWAYS.

ABINGTON, MASS.—The Abington & Rockland Ry. Co. will commence work shortly, and will try to have the road in operation by October. The Whitman branch will be built later.

PHILADELPHIA, PA.—The Philadelphia, Cheltenham & Jenkintown Electric Ry. Co. has been organized. Pres., John H. Fow; Secy., F. L. Lyle.

SANDUSKY, O.—The Sandusky, Milan & Huron Electric Ry. Co., with a capital stock of $100,000, has been incorporated by W. H. Gilcher, Geo. H. DeWitt and T. B. Taylor.

GALVESTON, TEX.—A plan for an electric railway to Houston, to carry passengers and local freight, is proposed by Mr. McGoldrick, of San Antonio.

MONTEREY, MEX.—The Companhia de Tranvias Electricas de Monterey, or Monterey Electric Railway Co., has been organized at Jersey City, N. J., by A. E. Crocker and I. Garcia, of Monterey. Capital stock, $1,000,000.

ELEVATED RAILWAY.

CHICAGO, ILL.—It is stated work will be commenced soon on the west side elevated railway by the Metropolitan Elevated Ry. Co. Col. A. F. Walcott is Treasurer and Hermann Binze in chare of the right of way department.

HIGHWAYS.

OHIO.—The Butler County Commissioners, at Hamilton, have adopted the plans of Engineer C. Weaver for paving the road from Madison to Middletown and under the law authorizing decided to issue $25,000 worth of county bonds for the work, have advertised for bids for the bonds and will receive the bids up to Sept. 14.

INDIANA.—Proposals for the construction of a turnpike from Leavenworth to Marengo, 13½ miles, according to plans and specifications on file, will be received until Sept. 7 by R. H. Willett, Secy. and Treas., Leavenworth, Ind.

COLORADO.—Proposals for the construction of a state wagon road in Clear Creek Co. will be received until Aug. 24 by J. P. Maxwell, State Engineer, Denver, Colo. The amount available is $4,500.

MONTANA.—The Cascade County Commissioners will receive bids until Sept. 5 for grading roads. Howard Crosby, Co. Clk, Great Falls.

BRIDGES, TUNNELS AND CANALS.

ROCHESTER, N. Y.—The bridge committee will recommend the construction of a stone arch bridge at Andrews St., to cost $75,000.

JERSEY CITY, N. J.—Bids will be received until Aug. 23 for building a highway bridge over the tracks of the Central R. R. of New Jersey at Bayonne. Ch. Engr., Board of Chosen Freeholders, Fuller Building.

LANSING, MICH.—This city has voted $25,000 of bonds for building a bridge at Franklin St.

WATER-WORKS.

New England.

PORTLAND, ME.—It is reported that the Belleville Water Co. has been organized here to own and operate works in the United States. Pres., Theodore C. Woodbury, Portland; Treas., Frederic E. Tabor, Portland.

ASHLAND, N. H.—A supply will be introduced from Jackson Pond. The contract requires that the works be finished this year.

NANTUCKET, MASS.—The town has appointed Allen Coffin, H. G. Worth and A. C. Jones a committee to report on town works. A company built works in 1878.

PITTSFIELD, MASS.—It is stated that the town will advertise for bids for a dam at Hathaway Brook. The dam will be of masonry in cement, 70 ft. long, 12 ft. high, 12 ft. thick at the bottom and 6 ft. at the top.

STRATFORD, CONN.—Another attempt to secure a charter for a company will probably be made when the next legislature meets.

Middle.

ITHACA, N. Y.—It is reported that a new company has been organized and that East Hill will be supplied from Cascadilla Creek; $50,000.

MIDDLETOWN, N. Y.—The Water Commissioners wish bids for a new supply plant consisting of driven wells, a 1,500,000-gallon Worthington pump and a boiler.

MOUNT VERNON, N. Y.—It is reported that meters will be placed in all houses.

NEWTOWN, N. Y.—The town has granted a franchise to Mayor Gleason of Long Island City and others. Two hydrants per mile will be furnished by the company free and 5% of the company's net earnings will be paid to the town.

RIVERHEAD, N. Y.—The Riverhead Water Co., with works nearly completed, has been incorporated; $15,000; Directors, Geo. W. Cooper, J. R. Perkins and others.

MOORESTOWN, N. Y.—An engineer will report upon increasing the water supply.

ALTOONA, PA.—Engr., C. W. Knight, Rome, N. Y., has been instructed to prepare plans for an impounding reservoir at Kittaning Point.

EVERETT, PA.—It is reported that the Everett Water Co. has been incorporated; $6,000; Directors, H. H. Hill, J. C. Barndollar and H. C. Loshley.

MORRISVILLE, PA.—Oct. 4 the people will vote on issuing $12,000 of bonds for works.

NEWPORT, PA.—Works are again projected.

POINT MARION, SPRINGHILL TOWNSHIP, PA.—The Point Marion Water Co. has been incorporated; $5,000; Treas., John M. Core, Uniontown; Directors, John Boyd, J. R. Barnes and others, Uniontown.

STEELTON, PA.—The Steelton Home Water Co. has been incorporated; $80,000; Treas., Dr. E. H. Leffler, Millersburg, Pa.; Directors, F. R. Gilbert, Millersburg; P. D. Wanner, Reading, and others.

LONACONING, MD.—An election will be held Aug. 20 to vote on issuing $40,000 of bonds for works.

PERRYVILLE, MD.—The Perryville Water Co. has bought water rights on Mill Creek and proposes to build works at once.

Southern.

AIKEN, S. C.—A contract for works to be in operation by November has been closed.

NEWNAN, GA.—A water company has been incorporated; $10,000, with privilege of increasing to $100,000.

NATCHEZ, MISS.—The property of the Natchez Water & Sewer Co. has been sold at auction to Jas. S. Richardson, New Orleans, for $126,000. Mr. Richardson bought the works Nov. 28, 1891, but a defect in the title or otherwise rendered another sale necessary.

HARRISON, TENN.—A franchise to the Harrison Water Co., giving the city an option of buying the works, is before the Council. For description of temporary works, see Manual of American Water-Works for 1890-1891.

MILAN, TENN.—Address Secretary Commercial Club regarding proposed works.

MAYSVILLE, KY.—The company will probably extend its works into the Sixth Ward.

North Central.

CELINA, O.—Works are talked of.

READING, O.—A combined city water and electric lighting plant is proposed; estimated cost, $40,000. A vote on the question will probably be taken at the fall election.

LAFAYETTE, IND.—It is probable that works to supply West Lafayette will soon be built under a franchise already granted. C. Callahan and W. H. Caulkins are interested.

DETROIT, MICH.—The Water Commissioners have decided to buy a new pumping engine, probably of 24,000,000 gallons capacity. Comr. Kirby has the matter in charge at present.

GRAND RAPIDS, MICH.—A proposition to put in a filtering plant has been made by E. H. Riddell, Chicago, representing the New York Filter Co.

LOWELL AND VERGENNES, MICH.—The Lowell Water & Light Co. has been incorporated to supply these places; $200,000; Directors, E. F. Sweet, A. C. Sekell, and others. Vergennes will be the principal place of business for the present.

BELLEVILLE, ILL.—The new company, recently noted, has accepted a franchise and will apply for incorporation.

SAYBROOK, ILL.—Works are talked of, merely, water having been found during an attempt to sink a coal shaft.

YELLOW CREEK, ILL.—The Village Board has advertised for bids for complete works.

IRON RIVER, WIS.—The organization of an electric light and water company with a capital stock of $50,000 is proposed.

NEENAH, WIS.—Plans for works have been made by Engr., Geo. W. Sturtevant, Jr., Chamber of Commerce Building, Chicago, and bids will be received until Aug. 23. A 16-in. intake 1,450 ft. long will extend to a 24 x 24-ft. crib, in Lake Winnebago. There will be two 1,250,000-gallon duplex and a 1,500,000-gallon pumping engine; 20 x 40-ft. steel stand-pipe on octagonal tower 25 ft. in diameter at the bottom, 20½ ft. at the top, and 70 ft. high; about five miles of mains, 64 hydrants and 20,000 lbs. of special castings.

NEW RICHMOND, WIS.—The people have voted $14,500 for works.

PRENTICE, WIS.—Works are being built.

Northwestern.

DUNLAP, IA.—The Town Council has been petitioned to take action regarding the building of works.

ELDON, IA.—A contract for $10,00 works has been let. There will be tube wells and a reservoir.

ODEBOLT, IA.—Preliminary steps have been taken for the purchase of the works by the city. It is stated that the city has always owned some stock and that the Council has decided that the only way to solve the difficulties attending the regulation of the rates is to buy the works.

MINNEAPOLIS, MINN.—Some large mains are to be laid.

BASSETT, NEB.—A special election will probably be held to vote on issuing bonds for works.

SYRACUSE, NEB.—Water and electric lighting plants are projected.

DEADWOOD, S. DAK.—Cy. Engr. G. H. Sharpe informs us that about $15,000 are available toward a city water supply. The city wishes to own works, but probably will not do much at present. A company furnishes the present supply.

STURGIS, S. DAK.—Bids will be received by the Sturgis Water Co. until Aug. 23, as follows: About 21,600 ft., or 552 tons 10 to 4-in. cast iron pipe; 10 tons specials; 30 hydrants; 24 16 to 4-in. valves and 22 valve boxes; for laying and setting the above, which comprises the distributing system; also for furnishing about 34,462 ft. or 822 tons of 16 to 6-in. cast iron pipe and 19 tons of specials; also for constructing a reservoir with about 8,650 cu. yds. of excavation; 6,500 cu. yds. of embankment; 2,000 cu. yds. clay puddle; 100 cu. yds. gravel or broken stone; 2,300 sq. yds. paving and 1,350 sq. yds. cement bottom. J. J. Davenport, Pres.; G. W. Ladd, Secy.; J. D. Cook, Toledo, O., Engr.

KALISPELL, MONT.—The Kalispell Water & Electric Co. has been incorporated; $250,000; J. A. Coram, F. E. Corbett and J. B. Wellcome; all of Butte. Works will be built as noted last week.

WALKERVILLE, MONT.—The Council has granted the Butte City Water Co. the privilege of laying mains in the streets.

Southwestern.

ST. LOUIS, MO.—Bids will be received by the Board of Public Improvements until Aug. 23 for hydrants and valves and laying mains.

FLATONIA, TEX.—The Council has appointed a committee with authority to offer a site and franchise and $1,000 to any company that will build works.

MARBLE FALLS, TEX.—The Ice, Light & Water Co. has been incorporated; $75,000; B. Badgers, O. J. Gorman, George Turner, and others.

Pacific.

SPOKANE, WASH.—The Manhattan Co. of the State of Washington has been incorporated to supply water to cities and for irrigation; $10,000,000; W. S. Norman, S. E. Borton, and others.

PORTLAND, ORE.—Supt. I. Smith estimates that a supply of 22,500,000 a day from Bull Run would cost $2,204,000, including reservoirs and pipe extensions in East Portland. Specifications will be prepared.

OAKLAND, CAL.—Another scheme to supply this city is on foot, artesian wells being the proposed source. The Alvarado Artesian Water Co., with a capital stock of $5,000,000, may be incorporated.

OGDEN, UTAH.—Alonzo Hertig has accepted the franchise for works recently granted to him.

ARTESIAN WELLS.

MIDDLETOWN, N. Y.—The Water Commissioners wish bids for a system of driven wells, with pumping plant.

SAN ANTONIO, TEX.—It is reported that the West End Town Co. will put down several wells.

IRRIGATION.

CALIFORNIA.—It is stated that ex-Mayor Cushing, Omaha, Neb., will build ditches between Los Angeles and San Francisco, which will water nearly 90,000 acres.

HARRISBURG, ARIZ.—John Roark, Phoenix, has the contract to build a dam below Harrisburg for the Harqua Halas Reservoir & Irrigation Co., recently incorporated; $100,000; Pres., J. B. Montgomery; Treas., Dr. O. L. Mahoney.

NEW COMPANIES.—Claremobut Irrigating Co., Englewood, Kan.; $30,000; Directors, C. D. and E. R. Perry and L. L. Ross.

SEWERS.

CALAIS, ME.—Mr. Willis E. McAllister, Superintendent of the Calais Water Co., writes us that plans for a system of sewers have been made by McClintock & Woodfall, of Boston, and that at the present time some short sewers are being built under Mr. Woodfall's supervision. It is not intended to do much in that line this year, as there is so much other road work to take care of.

SOUTHBRIDGE, MASS.—The contract for sewers has been let to George W. Cram, of South Norwalk, Conn.

NEW BEDFORD, MASS.—Abbott P. Smith has made a proposition to the city whereby he will construct 5,000 ft. of sewers free of cost to the city except when the depth exceeds seven feet.

SALEM, MASS.—Proposals for a 42-in. brick sewer 2,000 ft. long, in Webb St., will be received until Aug. 22. S. S. Merrill, Supt. of Sewers.

BEVERLY, MASS.—It is proposed to extend the sewerage system in consequence of the growth of the manufacturing district.

EAST GREENWICH, R. I.—It is expected that the town will employ an engineer to prepare plans and estimates for a system of sewers.

GLENS FALLS, N. Y.—The contract for the sewerage system has been awarded to Van Vranken & Buell, of Schenectady, N. Y., at $152,828.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Aug. 22 for sewers in six streets.

WATERLOO, N. Y.—Mr. Backus, the engineer, is making surveys for the sewer system.

BUFFALO, N. Y.—The Department of Public Works will receive bids until Aug. 24 for 12 to 30-in. tile sewers.

FULTON, N. Y.—The Village Trustees have engaged S. E. Babcock, Little Falls, to prepare surveys and estimates for a sewerage system.

NEW YORK, N. Y.—Specifications are nearly completed for an outlet sewer in 149th St. The maximum diameter will be 5 ft. and it is intended to drain 120 acres.

TROY, N. Y.—The Board of Contract will receive bids until Aug. 23 for a sewer in King St.

NEW ROCHELLE, N. Y.—A meeting will be held Aug. 23 to vote upon the issue of $75,000 in bonds, to complete the sewer system.

ORANGE, N. J.—The contract for the northern section of the sewers has been awarded to the Delafield Construction Co., of New York. The amount of the contract, according to the engineer's estimate, is a little over $84,000.

BETHLEHEM, PA.—The question of a system is being agitated.

CHESTER, PA.—It is proposed to issue bonds for $60,000 for sewers and a public wharf at South Chester.

MOBILE, ALA.—D. M. N. Ross, Cy. Engr., writes us as follows: "The city has engaged Samuel M. Gray, Esq., sanitary engineer, Providence, R. I., to prepare plans for sewerage and additional water-works for this city. These plans are not yet completed. The sewerage system will be commenced as soon after the receipt of th plans as possible, but whether outside bids will be asked for is a question that the City Council will determine. We have one of the best systems of water-works in the country, with pure, living springs of never failing water in the most abundant form, a reservoir seven miles from the city with a capacity of 12,000,000

gallons, and on an elevation of 210 ft. above the city, the required constant pressure being 80 lbs. This system is in every respect first class, yet the cost of supply to the city and citizens is considered excessive, being far above the average of other cities. For this cause and for the additional cause that our proposed sewerage system will require an abundance of water at a minimum cost that cannot be had from a private corporation without excessive charges and restrictions, the mayor and council have determined to put in a city plant that will be the property of the city, the charge to citizens being governed by actual cost and running expenses.

MACON, GA.—The suburb of Vineville proposes to establish a system of sewerage, and arrangements for connecting with the city system are now being made.

AKRON, O.—Bids are asked until Sept. 3 for furnishing the city with sewer pipe during the ensuing year.

CLEVELAND, O.—The Council has voted to construct sewers in four streets. The Board of Control will receive bids until Aug. 24 for a sewer in Walker St.

SANDUSKY, O.—The City Clerk will receive bids until Sept. 3 for a sewer in Jefferson St.

WARREN, O.—The City Engineer has completed preliminary surveys of Red Run Valley and a profile is being made to determine the feasibility of that route for a trunk sewer line.

YOUNGSTOWN, O.—The Council has passed an ordinance for a main sewer through three streets.

ELKHART, IND.—The City Clerk will receive bids until Aug. 24 for a sewer in East St.

ELWOOD, IND.—Plans are being prepared for a system of sewerage for the town. A part of the work, including about 1,200 ft. of 40-in. and 2,500 ft. of 36-in. brick and 4,000 ft. of pipe sewer, will soon be advertised. H. S. Freeman, Cy. Engr.

INDIANAPOLIS, IND.—The City Engineer has completed plans for a sewer 18 to 48-in., length 7,118 ft. The estimates include 16,220 cu. yds. excavation at $1, 8,500 cu. yds. at 80 cts., 795,200 brick at $20, 3,600 ft. sewer pipe, etc.; total $57,330.

CHICAGO, ILL.—The Council has passed orders for sewers in ten streets in Ward 30; also for a large number of other improvements.

DEADWOOD, S. DAK.—We are informed by Geo. H. Sharfe, Cy. Engr., that proposals will be opened Aug. 10 for about five miles of sewers, vitrified pipe, with iron pipe in places. The pipe is to be from 8 to 20-in. and the grades are very steep, running up to 15 and 17%.

FORT DODGE, IA.—The City Council has accepted the plans for a sewerage system prepared by Mr. G. F. Lavett, of St. Paul, Minn.

WAVERLY, IA.—Work will soon begin on a sewer system. It is intended to do the work a portion at a time until the system is completed.

FREMONT, NEB.—Proposals for a system of sewerage to cost about $50,000 will be received by the City Clerk until Aug. 30.

KANSAS CITY, KAN.—The City Engineer has submitted specifications for the extension of the state line sewer; estimate, $35,100.

HUNTSVILLE, TEX.—Efforts are being made to have a large sewer constructed to extend about a mile from the town.

PHOENIX, ARIZ.—The sewer company will complete the main pipes about Sept. 15. Application has been made for a charter to lay a system of pipes in Monroe and adjacent streets. Denver capitalists are interested in the new project.

SPOKANE, WASH.—The city has recently awarded contracts for sewers aggregating about $38,000, the city to furnish the pipe, which varies from 8 to 22-in., also contracts for grading six streets, the largest being at $22,220. J. W. Strack, Cy. Engr., informs us that no other contracts will be awarded for several weeks.

WINNIPEG, MAN.—A contract has been awarded to Robertson & Ross at $27,000.

STREETS.

PITTSFIELD, MASS.—The Highway Committee has decided to construct asphalt sidewalk, curb and gutter improvements in West St., at an estimated cost of $10,000.

PROVIDENCE, R. I.—The Council has voted to pave Charles St. with granite blocks, to cost $13,000, also to macadamize certain streets.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Aug. 24 for paving with cobble stones.

TONAWANDA, N. Y.—T. W. Barrally, Cy. Engr., writes us as follows: "Bids for bonds for $144,000 will be received Aug. 16 by the Village Treasurer. The work of paving is well under construction, about half a mile being completed. Vitrified paving brick are used."

ERIE, PA.—It is claimed that the proposed boulevard is an assured fact. The contemplated roadway will be 200 ft. wide, curbed and macadamized with furnace slag. The estimated cost is about $16,000 per mile or $80,000 complete.

JOHNSTOWN, PA.—A loan of $60,000 for street improvements is being considered by the Council.

YORK, PA.—J. G. Durpin, Cy. Engr., informs us that the city intends to do some street paving, grading and macadamizing, and possibly have a sewerage system designed.

NORFOLK, VA.—The Council has voted $20,000 for street improvements in Brambleton.

STAUNTON, VA.—C. H. Harrison, Cy. Engr., writes us as follows: Will say our city has been engaged in general street improvement for 18 months. We have 1½ miles of brick paving, ½ mile of granite paving and all the residential streets nicely macadamized. We have spent about $50,000 already, and recently issued bonds to the amount of $40,000 to defray the expenses of work still to be done, making an outlay on streets of $95,000. The contracts have all been awarded and the work is in progress.

MEMPHIS, TENN.—The Board of Fire Commissioners will receive bids until Aug. 25 for improving two streets by grading, constructing stone gutters and macadam roadways.

AKRON, O.—Bids are asked until Sept. 3 for improving Spruce St. by sewering, grading, curbing, guttering and paving the roadway with brick. S. W. Parshall, Cy. Engr.

CINCINNATI, O.—The Board of Administration will receive bids until Sept. 1 for paving with granite blocks, and until Sept. 6 with asphalt, one street at each date. Contracts for paving with brick have been awarded to P. Murray & Sons., at $57,321 and W. A. Adams, at $28,968.

CLEVELAND, O.—The Council has passed ordinances for paving two streets with asphalt, four with brick, and six with dressed block medina sandstone.

HAMILTON, O.—Proposals for improving and paving C St. according to the plans and specifications of the City Engineer will received until Sept. 6. J. J. McMaken, Cy. Clk.

DAYTON, O.—The City Comptroller has been authorized to advertise for bids for paving alleys.

DEFIANCE, O.—The Council has voted to pave several streets.

FREMONT, O.—The Committee on Improvements will receive bids until Sept. 12 for paving two streets with fire brick; also for a tile sewer.

GREENVILLE, O.—The city will receive bids until Sept. 5 for the improvement of Thirteenth St.

LIMA, O.—The Council has order the improvement of three streets.

TOLEDO, O.—The Council has declared it necessary to pave three streets with brick, medina stone, cedar blocks, or asphalt, and construct sidewalks in six streets.

YOUNGSTOWN, O.—The Council has voted to issue bonds for $25,000 to pave Madison Ave. with asphalt.

CRESTON, IA.—The contract for paving ten blocks with vitrified brick has been awarded to Barns & Co.

KANSAS CITY, MO.—The Board of Public Works has recommended that Prospect St., 4,393 lin. ft., be paved with asphalt.

ELECTRICAL.

CONCORD, N. H.—The city has an offer from the Concord Land & Water Power Co. for lights of 1,200 c. p. at $85 each per year for ten years, with the additional offer of a lower rate for such time as the corporation should be given the exclusive privilege of stringing poles and wires for the transmission of electricity for street lighting generated by water power.

BRISTOL, VT.—Parties from Boston, Mass., and Rutland, Vt., are arranging to establish an electric plant. Contracts have already been secured for about 500 lamps, and to furnish power for a 40 HP. motor. It is proposed to extend the line to Lincoln.

PERRY, N. Y.—The Perry Electric Light & Power Co. has been awarded a franchise, and a contract for five years for 20 arc lights at $52 per light per year. The works will be completed about Nov. 1.

MIDDLETOWN, PA.—The citizens have voted to light the streets by electricity.

ROANOKE, VA.—The Board of Public Works will receive bids until Sept. 5 for electric street lighting. The city is now using about 300 gas and oil lamps.

TITUSVILLE, FLA.—We are informed by S. F. Gray, Secy., Titusville Electric Light Co., that the company intends to put in steam power, sufficient for 1,500 lights of 16 c. p. The company now has steam power for 500 lights and a 700-light dynamo.

GRUNDY CENTER, IA.—At a special election the citizens voted 156 to 68 in favor of authorizing the Council to light the city by electricity. Bonds will be issued.

IOWA FALLS, IA.—The City Recorder will receive bids until Sept. 5 for an electric light franchise.

SPRINGFIELD, MO.—The City Clerk will receive bids until Sept. 6 for furnishing the city and citizens with electric lights.

NEW COMPANIES.—Lowell Water & Light Co., Vergennes, Mich.; $200,000; E. F. Sweet, A. C. Sekell, C. J. Church, Greenville. Rumford Light & Water Co., Rumford Falls, Me.; $100,000; Pres., Geo. D. Bisbee; Treas., Waldo Pettengill. Citizens' Electric Light & Power Co., Newark, N. J.; $1,500,000; F. Z. Maguire, New York, and F. A. Magowan, Trenton. People's Electric Light & Power Co., Jersey City, N. J.; $1,000,000; F. Z. Maguire, New York, and F. A. Magowan, Trenton.

CONTRACT PRICES.

IRON PIPE.—Jackson, Mich.—The contract for about 400 tons of iron pipe for the water-works has been awarded to the National Foundry & Pipe Works, Scottdale, Pa., at $22.50 per ton.

STREET WORK.—Marietta, O.—The lowest bids received for paving with brick were as follows: Hallwood block, $1.34; Canton shale, $1.22; Canton repressed, $1.32; Porter standard, $1.13; Porter repressed, $1.19; Freshwater, 98 cts.; State line, $1.22; Jones, $1.00; Bellaire, 99 cts.; Cisler, 85 cts.; South Zanesville, $1.14; Portsmouth, $1.72; Stratton, Hinkle & Stratton, $1.22; Smith, Porter & Co., $1.54; Canton & Malvern, $1.36; Waynesburg fire clay, $1.30; Parto block, $1.35. The bids for curb ranged from 37 to 60 cts. per lin. ft.

Boston, Mass.—The following contracts were awarded Aug. 8: H. Gore & Co., paving 6,120 sq. yds. with granite blocks on gravel, 90 cts. and $1.08 per sq. yd.; 3,300 lin. ft. edgestone, 30 and 38 cts.; 2,450 sq. yds. brick sidewalk, 60 and 65 cts.; 275 sq. yds. flagging crosswalk, $1.10 and $1.20; Collins & Ham, 2,150 sq. yds. granite blocks on gravel, 90 cts.; 1,550 lin. ft. edgestone, 48 cts.; 550 sq. yds. brick sidewalk, 80 cts.; 30 sq. yds. flagging sidewalk, $1.50; A. A. Libby & Co., 3,800 sq. yds. granite blocks on gravel, $1.05; 2,200 lin. ft. edgestone, 20 cts.; 1,400 sq. yds. brick sidewalk, 65 cts.; 280 sq. yds. flagging sidewalk, $1.50; C. J. Coates & Co., 3, 875 lin. ft. edgestone, 19 cts.; 1,286 sq. yds. gutter, 40 cts.; 2,750 sq. yds. sidewalk, 31 cts.

MISCELLANEOUS.

IRON WORK.—Washington, D. C.—Bids will be received until Aug. 25 for furnishing, delivering and erecting in place the iron work of the dome and lantern of the Congressional Library Building. Bernard R. Green, Supt. and Engr.

STONE, ETC.—Washington, D. C.—Bids will be received at the U. S. Engineer office until Sept. 7 for oyster shells, riprap stone and constructing jetty at Nomini Creek, Va.; for dredging and furnishing riprap stone at Occoquan Creek, Va.; and for gravel, building stone, riprap stone and dredging in Potomac River. Maj. Chas. E. L. B. Davis.

GAS.—Pasadena, Cal.—We are informed that Prof. Lowe has concluded arrangements for doubling the capacity of the gas works and for extending the street main system so as to cover a more extended area.

DAM.—Vicksburg, Miss.—The Board of Supervisors of Warren Co. will receive bids until Sept. 5 for dams across Glass Bayou.

DREDGING.—New York, N. Y.—Bids will be received at the U. S. Engineer office until Sept. 13 for dredging Red Hook Shoal, in Buttermilk Channel. Lieut.-Col. G. L. Gillespie.

Burlington, Vt.—Bids will be received at the U. S. Engineer office until Sept. 8 for dredging about 92,000 cu. yds. from the Narrows of Lake Champlain; 21,000 cu. yds. of clay, sand and boulders from Great Chazy River; and 2,000 cu. yds. of slate rock from a ledge in Otter Creek.

MASONRY.—Brookline, Mass.—The Park Commissioners will receive bids until Aug. 22 for masonry structures along Pond Ave., on the Muddy River improvement.

GRAVEL AND STONE.—Boston, Mass.—The Metropolitan Sewerage Commissioners will receive bids for 1,000 cu. yds. clean screened gravel, and 1,000 cu. yds. crushed stone, for concrete.

DRY DOCK.—Washington, D. C.—Bids will be received until Sept. 10 for a dry dock at Puget Sound naval station—length, 903 ft.; draft, 30 ft. The body is to be of timber and the entrance of concrete and masonry. N. H. Farquhar, Chief of Bureau of Yards and Docks, Navy Dept. The dock was described and illustrated in our issue of May 19.

DRY DOCK.—Washington, D. C.—In consequence of the new eight-hour law the Navy Department will receive new bids for the construction of the Puget Sound dry dock, described in our issue of May 19.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have built 10 four-cylinder Vauclain compound engines for the Long Island; they are tank engines similar to those used on the Chicago & South Side elevated railway; the Baldwin Works have also built 4 four-cylinder compound consolidation engines for the Buffalo, Rochester & Pittsburg. The Rhode Island Locomotive Works, Providence, R. I., have an order for two two-cylinder compound engines for the Minneapolis & St. Louis. The Chicago, Burlington & Quincy will add 50 locomotives to its equipment.

CARS.—The American Car Co., St. Louis, Mo., has an order for 20 vestibuled electric cars for the Minneapolis Street Railway; they are to be 41 ft. long and will run between St. Paul and Minneapolis. The Automatic Refrigerator Car Co., Portland Me., has been incorporated; $250,000; Pres., David Dennis, Gardner, Me. The Canadian Pacific is building 100 grain cars and a number of box and flat cars at its shops at Perth, Ont. The Chicago, Burlington & Quincy will add to its equipment 50 passenger cars, 55 chair cars, 1,000 stock cars, 1,000 coal cars and 200 furniture cars.

CAR SHOPS.—The Jones Sleeping Car Co., Denver, Colo., has awarded the contract for the first of the buildings for its new works to J. H. Ross & Co., of Denver. The building is to be of brick, 40 × 70 ft. It is said that a contract for a machine shop 100 × 250 ft., will be let shortly.

CAR LIGHTING.—A Pintsch compressed gas plant is to be established at Toledo, O., with a capacity of 400 cars, for the supply of Lake Shore & Michigan Southern equipment. The Wabash and Cincinnati, Hamilton & Dayton cars will also be supplied from the same plant.

NEW COMPANIES.—Indianapolis Switch & Frog Co., Indianapolis, Ind.; $300,000; Fred Gray, Wm. H. Parmlee, H. V. Horton and T. R. Stratford. Itaska Iron Co., Chicago, Ill.; $5,000,000; to develop ore resources; Frank Barrett, of St. Paul; Robt. J. Dean, of New York. Hancock Switch & Frog Co., Manchester, N. H.; L. G. Lane, J. W. Beal and J. C. Lovejoy. Toledo Street Cleaning & Improvement Co., Toledo, O.; $20,000; F. O. Paddock, C. Carpenter and H. E. King.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $18 for iron and $13.50 for steel. Pittsburg: $30; old rails, $19 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; old rails, $18 to $18.25 for iron and $12 to $13 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.5 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.8 cts. for iron and steel; spikes, 2.05 to 2.1 cts.; track bolts, 2.65 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron discounts as follows, at Pittsburg: 60 and 52½ per cent. on black and galvanized butt-welded; 70 and 60 per cent. on black and galvanized lap-welded. Casing 55 per cent.

FOUNDRY PIG IRON.—New York: $13.50 to $15.50 Pittsburg: $13.25 to $14.50; Chicago: $13.50 to $15.

LEAD.—New York: 4 to 4.1 cts. Chicago: 3.97 cts. St. Louis: 3.9 cts

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.4 to 2.75 cts. for small lots, channels, 2.25 to 2.5 cts.; angles 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.9 to 2.1 cts.; steel plates, 1.95 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.05 cts. for large lots, and 2.1 to 2.15 cts. for small lots; channels, 2 to 2.05 for large lots, and 2.1 to 2.15 cts. for small lots; angles, 1.9 to 2 cts.; tees, 2.45 cts.; universal mill plates, 1.85 to 1.9 cts. for iron and 1.9 to 2 cts. for steel; sheared steel bridge plates, 2.05 to 2.15 cts.; refined bars, 1.7 to 1.75 cts. for iron and steel; steel plates, 1.85 to 1.95 cts. for tank, 2 to 2.2 cts. for shell, 2.1 to 2.2 cts. for flange, 3.6 to 3.75 cts. for firebox. Chicago: beams, 2.3 to 2.35 cts. for large lots, and 2.5 cts. for small lots; channels, 2.15 to 2.25 cts.; angles, 2.1 to 2.25 cts.; tees, 2.4 to 2.6 cts.; universal plates, 1.9 cts.; sheared steel plates, 2.3 to 2.4; steel plates, 2.3 to 2.4 cts. for tank, 2.3 shell, 2.75 to 3 cts. for flange.